

TYPE O AND ON CARRIER TELEPHONE SYSTEMS

TERMINALS AND JUNCTIONS

GENERAL INFORMATION – OVER-ALL SYSTEM

DESCRIPTION – TYPE ON1 AND ON2 CARRIER TELEPHONE SYSTEMS

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1. GENERAL

1.01 This section provides an over-all system description of the ON1 and ON2 carrier systems. At present, the ON1 system is used primarily for transmission over a combination of cable or radio and open wire, and the ON2 for transmission over an all-cable or radio facility. The ON1 system may be used as an all-cable system. An over-all system consists of O1-type carrier units located at the terminals and a high-frequency line made up of cable and N-type repeaters or a combination of cable and N repeaters and open wire and O-type repeaters. Detailed descriptions of the terminals, junctions,

and the repeated line are contained in Sections 362-100-100 and 362-400-100.

1.02 This section has been reissued to include information on the ON2 carrier telephone system, and since this reissue incorporates a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The ON1 and ON2 carrier terminals consist primarily of O1 carrier channel units and modified O1 group and twin-channel units. Both the ON1 and the ON2 systems transmit and receive in a low-group frequency band (frequency allocations are shown in Fig. 1) and an ON repeater is always required between the terminal or the ON1 junction and the N high-frequency line in both transmitting and receiving directions.

ON1 System

1.04 A complete ON1 system includes terminal equipment at each end of a high-frequency line which provides five groups of four message channels each. Thus 20 channels may be transmitted via an appropriate ON repeater to the N-type line. An ON1 system employs, on the N carrier line, a low-group frequency band of 40 to 136 kc and a high-group band of 168 to 264 kc. The frequencies on the high-frequency line are frogged at each repeater point so that if the repeater input frequencies are in the low-group band the output frequencies will be in the high-group band, or vice versa. A fully equipped ON1 system will provide twenty 2-way channels over two pairs in an N-type cable. Either the 3700-cycle built-in E and M lead signaling or in-band signaling may be used in the ON1 system. In the case of in-band signaling, optional channel units without built-in signaling are used. In the ON1 system over a combination of cable and open wire, transition is accomplished through

SECTION 362-100-150

use of an ON1 junction which contains equipment necessary to perform the required steps of modulation. Typical all-cable and open-wire to cable arrangements are shown in Fig. 2 and Fig. 3.

1.05 The ON1 system enables more efficient use of an N-type cable facility than N carrier, allowing 20 channels to be transmitted on a cable pair compared to 12 channels with the N carrier system. If an ON1 system is only partially

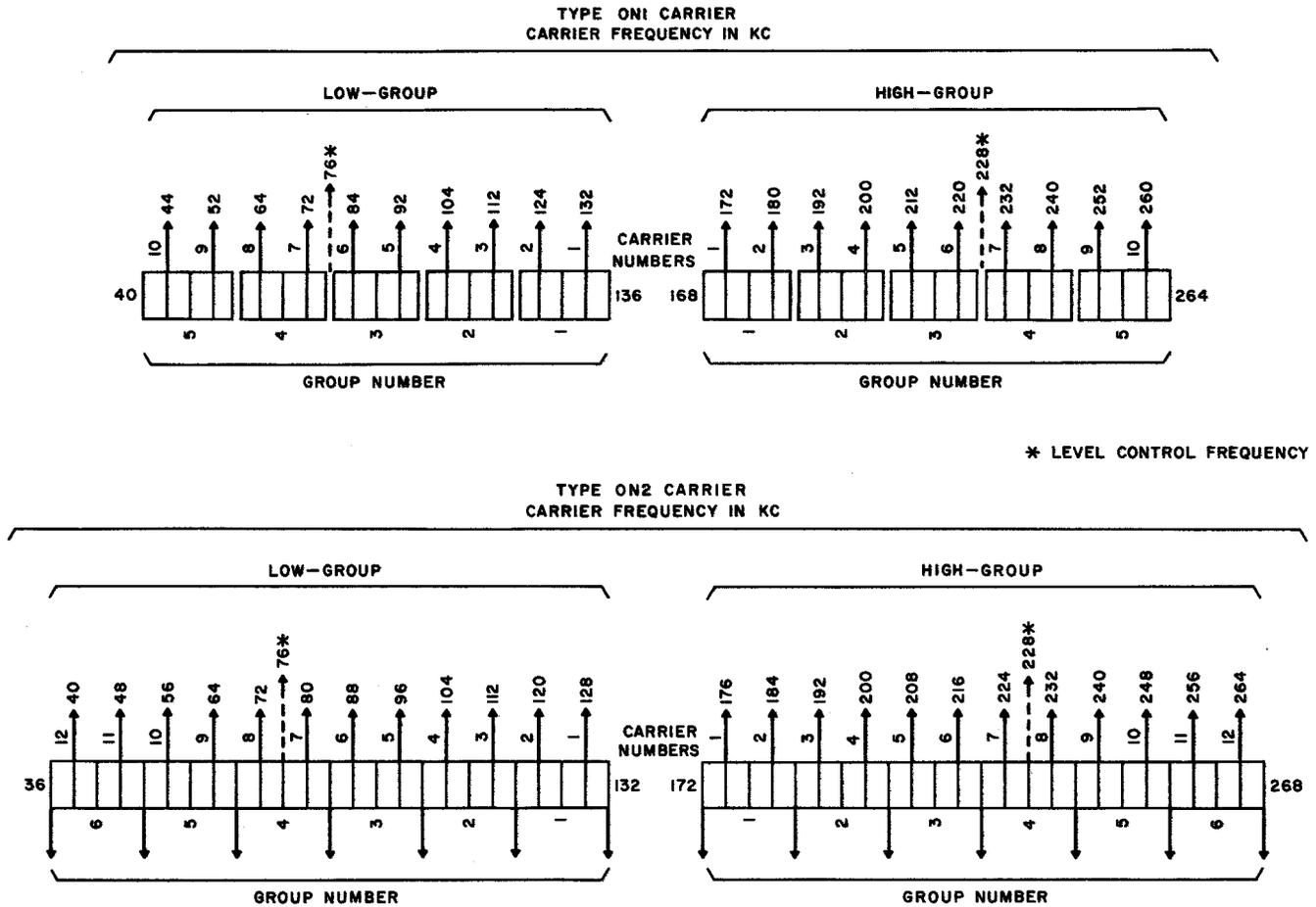


Fig. 1 — ON Carrier Frequency Allocations

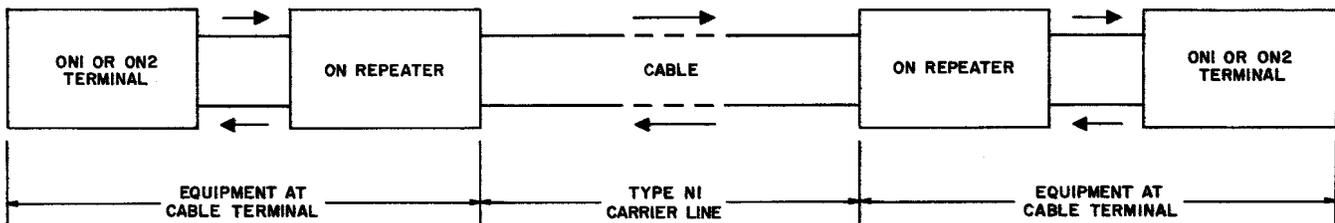


Fig. 2 — Typical ON System All-Cable Layout

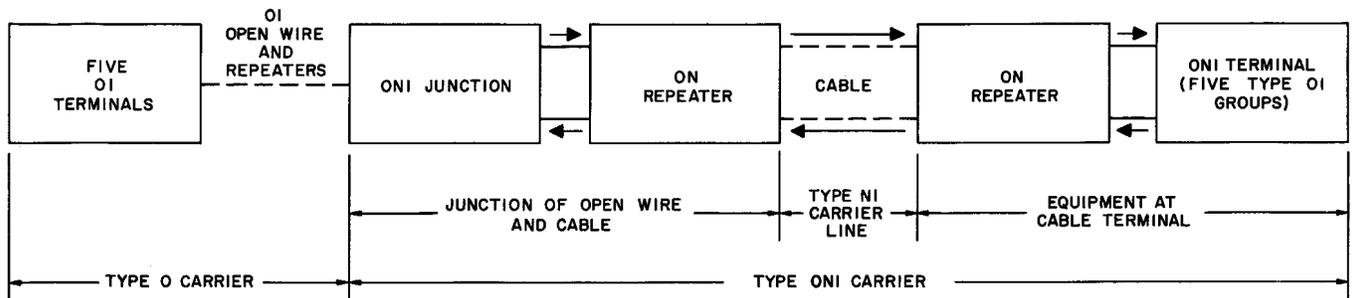


Fig. 3 — Typical ON1 System Open-Wire to Cable Layout

equipped, provision is made to add a level control tone. This tone ensures total power on the line even though the system is only partially equipped. Maintaining total power is required because repeaters regulate on a total power basis. The frequency of the level control tone is 76 kc and is always used if the system is not fully equipped. The proper order in which to equip an ON1 system is first group 1, then 2, 3, 5, and finally 4. A circuit layout illustrating the flexibility of the ON1 carrier system is shown in Fig. 4.

1.06 The ON1 system may be extended on radio facilities. In this application, a 20-channel ON1 system in a normal low-group frequency band is combined with another 20-channel ON1 system which has been translated, via a repeater, to the high-group band. This combination provides up to 40 message channels for transmission over radio facilities. In addition, a similar arrangement of a high- and low-group band may be further modulated by radio multiplex equipment, thus providing up to 80 channels for transmission over radio. The ON1 system must be used for the extension of radio circuits over open wire, since ON2 equipment is not available for this.

ON2 System

1.07 In the ON2 carrier system the 4-kc spacing between groups, characteristic of the ON1 system, has been eliminated to provide an additional group of four message channels. The ON2 system thus consists of six O-type groups, with each group containing four message channels. The 24 channels are transmitted from and received at the terminal in a low-group band of 36 to 132 kc. The standard N-type line repeaters alternately translate the line frequencies from high to low group as in the N and ON1 systems.

Also, as in the case of ON1, an ON repeater is required between the ON2 terminal and the N line.

1.08 The ON2 carrier system provides up to 24 channels for transmission over N-type cable as opposed to the 20 channels of the ON1 system. As in the ON1 system, the line frequencies are such that the low-group band is transmitted in one direction and the high-group band in the other direction. The preferred order of adding ON2 groups in a partially equipped system is first group 1, then 2, 3, 6, 5, and finally 4. A level control tone is provided in any system not fully equipped. The frequency of the level control oscillator is 76 kc.

1.09 The ON2 system may also be extended on radio facilities. In this application, an ON2 system in the low-group frequency range may be combined with another ON2 system that has been translated to the high-group frequency range and thus provide up to 48 channels for transmission over radio. Two additional ON2 systems arranged in the same manner may be modulated by radio multiplex equipment, thus providing up to 96 channels (4 ON2 systems) for transmission over radio. Junction equipment is not available for the transition from open wire to ON2 cable.

2. SYSTEM DESCRIPTION

A. System Arrangement

Open-Wire — Cable Arrangement

2.01 An ON1 system arranged for use with open wire and cable is shown in Fig. 5. The 20 channels shown are derived from five O-type systems. These five systems may be chosen

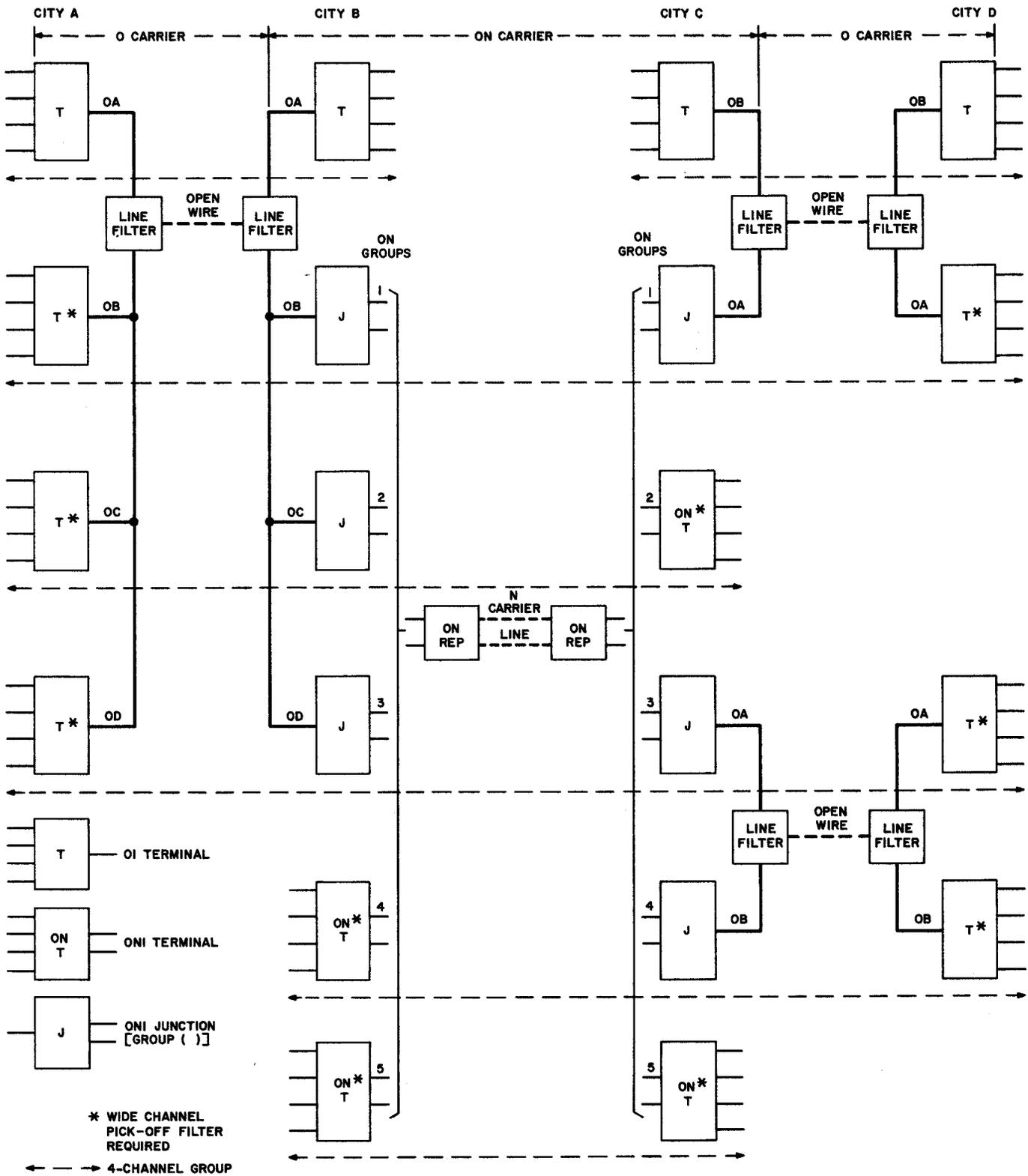
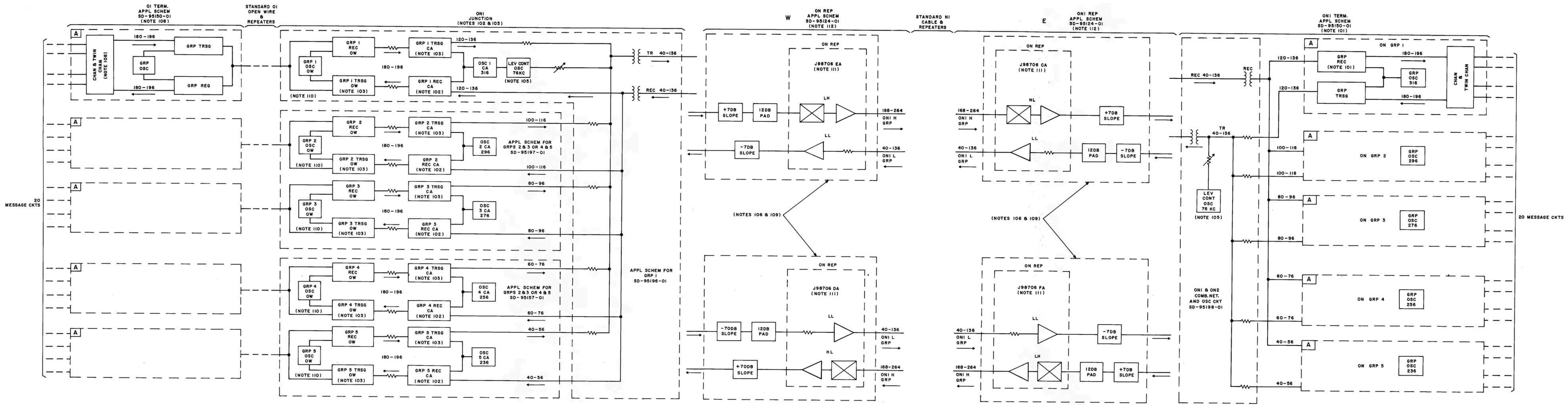


Fig. 4 — Circuit Layout Illustrating Flexibility of ON Carrier



- NOTES:
101. NO DIRECTIONAL FILTERS ARE USED. ONLY ONE OSC OF EACH STANDARD GROUP OSC UNIT IS USED. WIDE BANDPASS PICK-OFF FILTERS ARE REQUIRED IN TWIN CHANNEL UNITS.
 102. NO DIRECTIONAL FILTER IS REQUIRED IN GRP REC CA IN ANY GROUP OF THE ON JUNCTION.
 103. NO NOISE GENERATOR IS REQUIRED IN GRP TRSG OW & CA IN ANY GROUP OF THE ON JUNCTION.
 104. THE LOCATION OF THE GROUP 3 OSC OW AND THE GROUP 5 OSC OW IS IN THE GROUP 1 JUNCTION MTG.
 105. ADJUSTABLE OUTPUT OF LEVEL CONTROL OSC REPLACES THE MISSING CARRIER POWER OF A PARTIALLY EQUIPPED ON SYSTEM.
 106. ONE OR THE OTHER ON REPEATER CIRCUIT IS USED AS REQUIRED.
 107. SEE FIG. 21 FOR CHARACTERISTICS OF SLOPE NETWORK.
 108. TWIN CHANNEL 532 A & B PICK-OFF FILTERS OF OI CARRIER SYSTEM CONNECTED TO ON SYSTEM REPLACED BY WIDEBAND 532 D & E PICK-OFF FILTERS.
 109. THE W & E ON REPEATER ARRANGEMENTS SHOWN ARE APPLICABLE TO EITHER TERMINALS OR JUNCTIONS.
 110. NO 3700 μ OSCILLATOR TUBE IS REQUIRED IN ANY GROUP OSC OW OF THE ON JUNCTION.
 111. WHEN EXISTING REPEATERS PER J98706 C, D, E & F (NOW RATED "MFR DISC") ARE MODIFIED TO INCLUDE LIST R ("T OPTION"), THEY ARE INTERCHANGEABLE WITH THE CORRESPONDING REPEATERS J98705 CA, DA, EA & FA, PER LIST 2.
 112. SPAN PADS ARE PROVIDED AS SPECIFIED IN SD-95124-01.

Fig. 5 — Open-Wire - Cable ON System Schematic

from any combination of systems regardless of their open-wire arrangements. O-type systems that do not connect to the ON1 junction may be terminated in standard O1 terminals or may be continued on the open wire through an O1 repeater or carrier bypass and branching circuit.

2.02 The equipment on the open-wire side of the junction consists of standard O1 receiving-group, transmitting-group, and oscillator-group units. The channel units, filters, and frequencies used for this side of the junction are determined solely by the O-type system to which each group connects.

2.03 The equipment on the cable side of the junction consists of standard O1 transmitting-group units and modified O1 receiving- and oscillator-group units. The modifications provide inputs and outputs on the cable side on a 4-wire basis, and transmit and receive within each ON group in the same frequency band. The choice of equipment units, filters, and frequencies used in the cable side of the ON1 junction is determined by the group number.

2.04 The cable side of the junction is connected to an ON repeater. As shown in Fig. 5, there are four types of ON repeaters. Any one of the four may be associated with a junction or a terminal. The choice is based on the direction of transmission and the frequency bands that appear in the receiving and transmitting directions on the N-type line. Repeaters are designated LH-LL (low, high-low, low), etc. The first term refers to the repeater in the west-east (W-E) direction of transmission and the second term to east-west (E-W) direction. If no frequency translation is required between the terminal and the high-frequency line, an LL repeater is used. If frequency translation is required in the transmitting direction, an LH repeater is employed. If frequency translation in the receiving direction is required, an HL repeater is used. In Fig. 5, for example, at the west end of the cable an LH-LL repeater transmits high-group frequencies to the cable and receives low-group frequencies from the cable. Alternately, if the west junction were to transmit low-group frequencies, the LL-HL repeater would transmit low-group frequencies to the cable and receive high-group frequencies from the cable.

2.05 The outputs of the five ON1 terminal groups are combined in the combining network and oscillator circuit. The received carriers are connected through a transformer on this panel and then multiplied to the five terminal group inputs.

Open-Wire — Cable — Open-Wire Arrangement

2.06 An open-wire — cable — open-wire ON1 system is similar to the open-wire — cable arrangement shown in Fig. 5. In an open-wire — cable — open-wire system the ON1 terminal shown in Fig. 5 would be replaced by a junction and the arrangement of O-type systems on the open-wire side of the second junction would be independent of the arrangement on the open-wire side of the first junction. The same principles would apply to a cable — open-wire — cable arrangement.

All-Cable Arrangement

2.07 A block schematic of an all-cable ON1 or ON2 system is shown in Fig. 6. This arrangement consists of an ON terminal and repeater at either end of a standard N-type cable equipped with standard N repeaters. Normally, in all-cable arrangements the 24-channel ON2 system rather than the 20-channel ON1 system is used, thus making full use of the facilities.

B. Modulation Plan

2.08 The ON carrier modulation plan shown in Fig. 7 is designed to place up to six different 4-channel groups, each corresponding to an O-type group or system, in a frequency band capable of being transmitted over an N-type line. The plan is based on the use of the basic 4-channel band of 180 to 196 kc provided by the O-type equipment. Each basic group is modulated to an allocated ON low-group position by a group modulator and associated oscillator. The full ON1 complement of five groups covers a frequency range of 40 to 136 kc. A full ON2 complement of six groups covers a frequency range of 36 to 132 kc.

2.09 When the arrangement of the ON1 system requires that transmission to the first repeater section remain in the low-group band in order to coordinate with N-type systems, or for other reasons, the band of frequencies from 40 to

136 kc is applied to the line by the ON repeater (36 to 132 kc for ON2 systems) without further modulation. When transmission in the high group is required, the ON repeater applies a further step of modulation by employing a modulating frequency of 304 kc. This translates an ON low group to an ON high group.

2.10 The modulation plan is a 2-step process when applied at the junction of open wire and cable. The 4-channel groups are received on the open-wire line side of the junction at O-type line frequencies. Each group is then modulated to the basic 4-channel band of 180 to 196 kc. This band of frequencies is referred to as the baseband. The second step modulates each group to its ON1 low-group allocation. Because the baseband is common to each of the OA, OB, OC, and OD systems, the five ON1 groups may be connected to any combination of O-type systems.

2.11 The ON modulation plan as discussed in 2.08 through 2.10 applies to transmitting and represents the modulation steps applied in passing from the baseband to the N cable. In the receiving direction the process is reversed. Signals at the input of the ON repeater are received from the cable in either the high- or low-group band. When the signals applied through the receiving cable are in the low-group band, the ON repeater supplies amplification without modulation. The signals are then selected and modulated into 4-channel groups through use of group oscillators and filters in the junction or terminal. When the received signals are in the ON high-group band, the ON repeater supplies a step of demodulation to convert the signals to the low-group band for proper selection in 4-channel groups.

C. Channel Order

2.12 The orientation of the channel filters and channel units in the O system is dependent only on whether the terminal transmits low-group frequencies and receives high-group frequencies, or transmits high-group frequencies and receives low-group frequencies. In the ON system, it is desirable to keep the same physical arrangement of the channel units in each 4-channel mounting as is used in the O system, i.e., channel 1 in position 1 in the mounting. Because of the regrouping of frequencies, it is not possible

to maintain the same baseband channel order for all cases as is used in the O system. Two different channel orders are required in an ON system and these have arbitrarily been designated as channel order A and channel order B. The 529-type channel filters (except in earlier systems) or the 568-type program filters are marked so that they can be selected and oriented for either O carrier or ON carrier in either order A or order B. If one terminal has arbitrarily been set up for channel order A, the terminal at the distant end will have to be arranged for channel order B.

2.13 The order of the channels in the baseband and on the line for O and ON terminals for channel orders A and B is shown in Fig. 8. Only channel order A will be used for O systems not associated with ON systems. Either channel order A or B may be required at an O terminal associated with an ON system or at an ON terminal.

2.14 A typical ON channel allocation as applied to the five ON1 groups or six ON2 groups is shown in Fig. 9. This figure also shows how the channel filters and twin-channel units should be oriented after determining the correct channel order. To explain the reason for two different channel orders in an ON system, assume that the typical channel allocations shown represent group 2, 4, or 6 of an ON2 system and that the transmitting channel order in the baseband is channel order A. At the left side of the chart (see Fig. 9) the transmitting channel allocation in the baseband is then four to one in ascending frequency. This channel allocation will descend with frequency for groups 1, 3, or 5 at line frequencies; but since there is always an even number of modulation steps in the N-type line, the channel arrangement in the baseband at the receiving end (right side of chart) will also be four to one in ascending frequency. Because the channel filters are assembled in pairs in each can, if the received channel allocation is four to one, it must be one to four in the transmitting channel. Thus, the transmitting channel order at the right side of the chart will be just the reverse of the transmitting order at the left side. If terminals are located at both ends of the N line, the orientation of the channel filter and twin-channel units at the two ends will be reversed, and where channel order A transmitting occurs at the terminal on

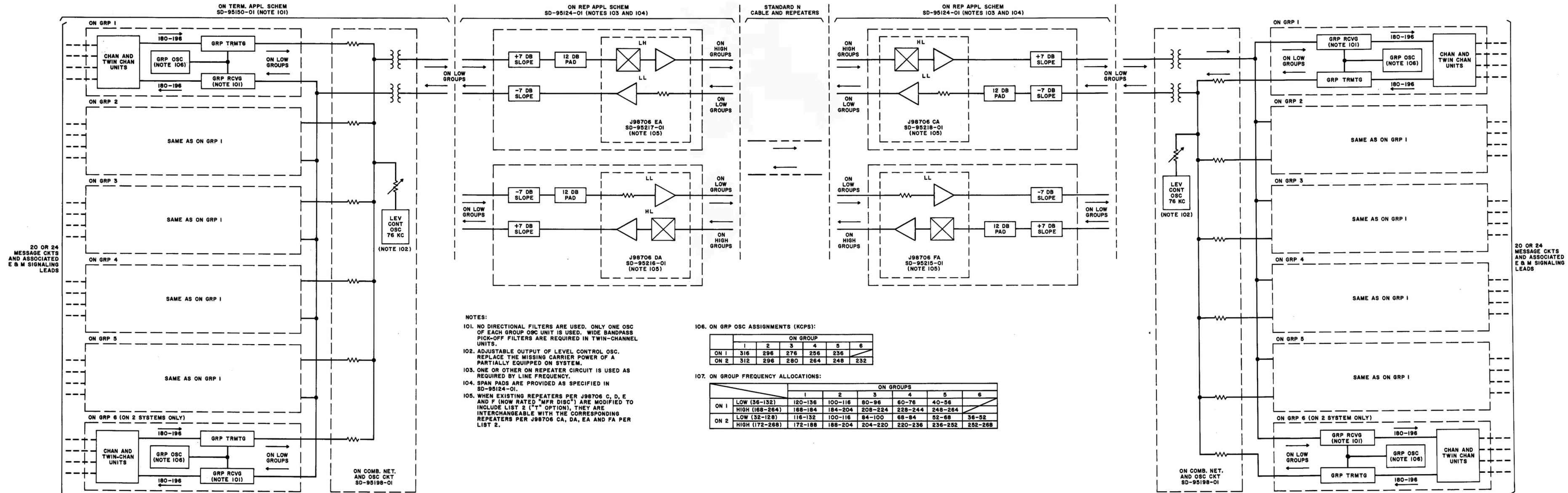


Fig. 6 — All-Cable System, Schematic

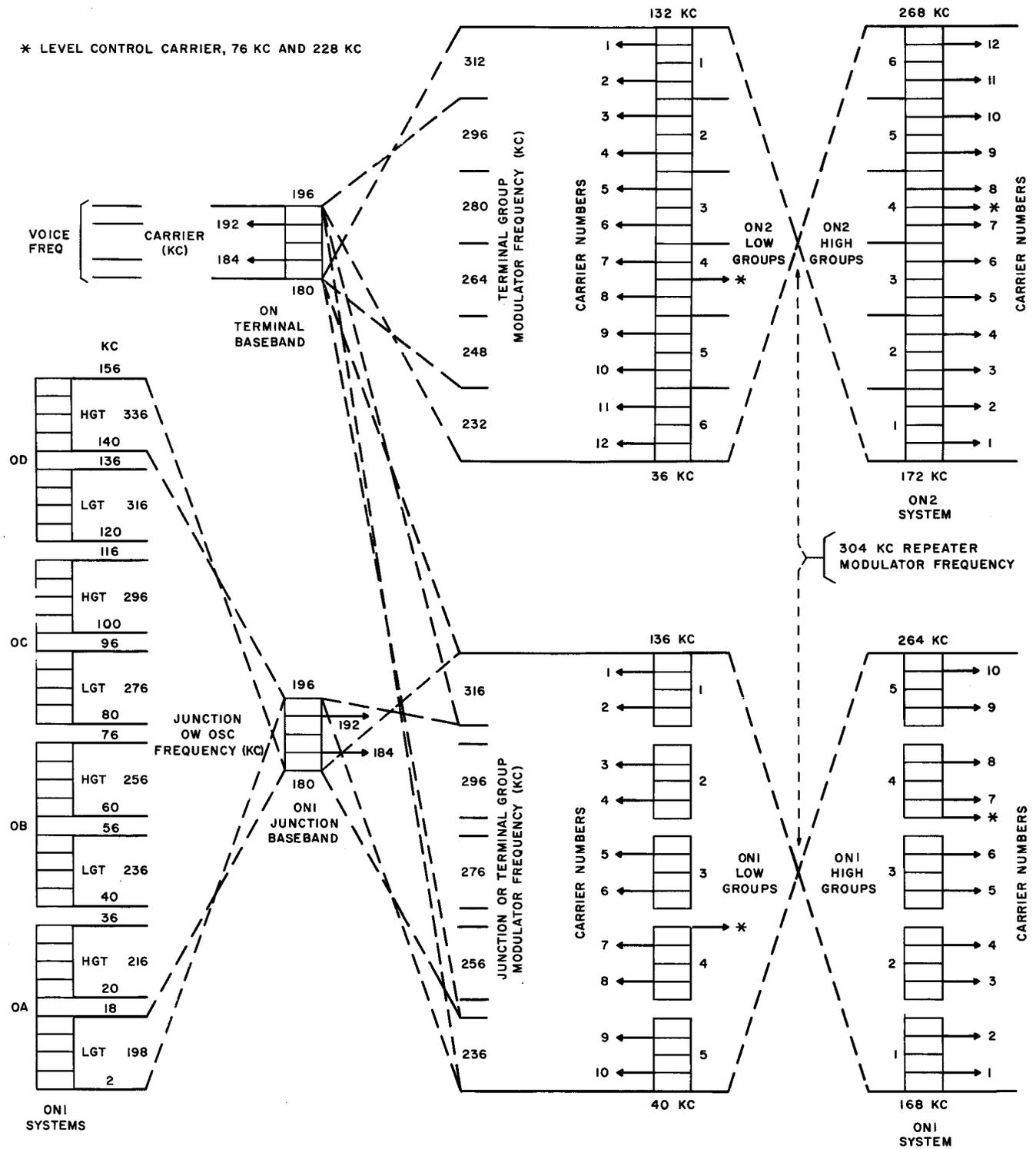


Fig. 7 — ON Carrier System Modulation Plan

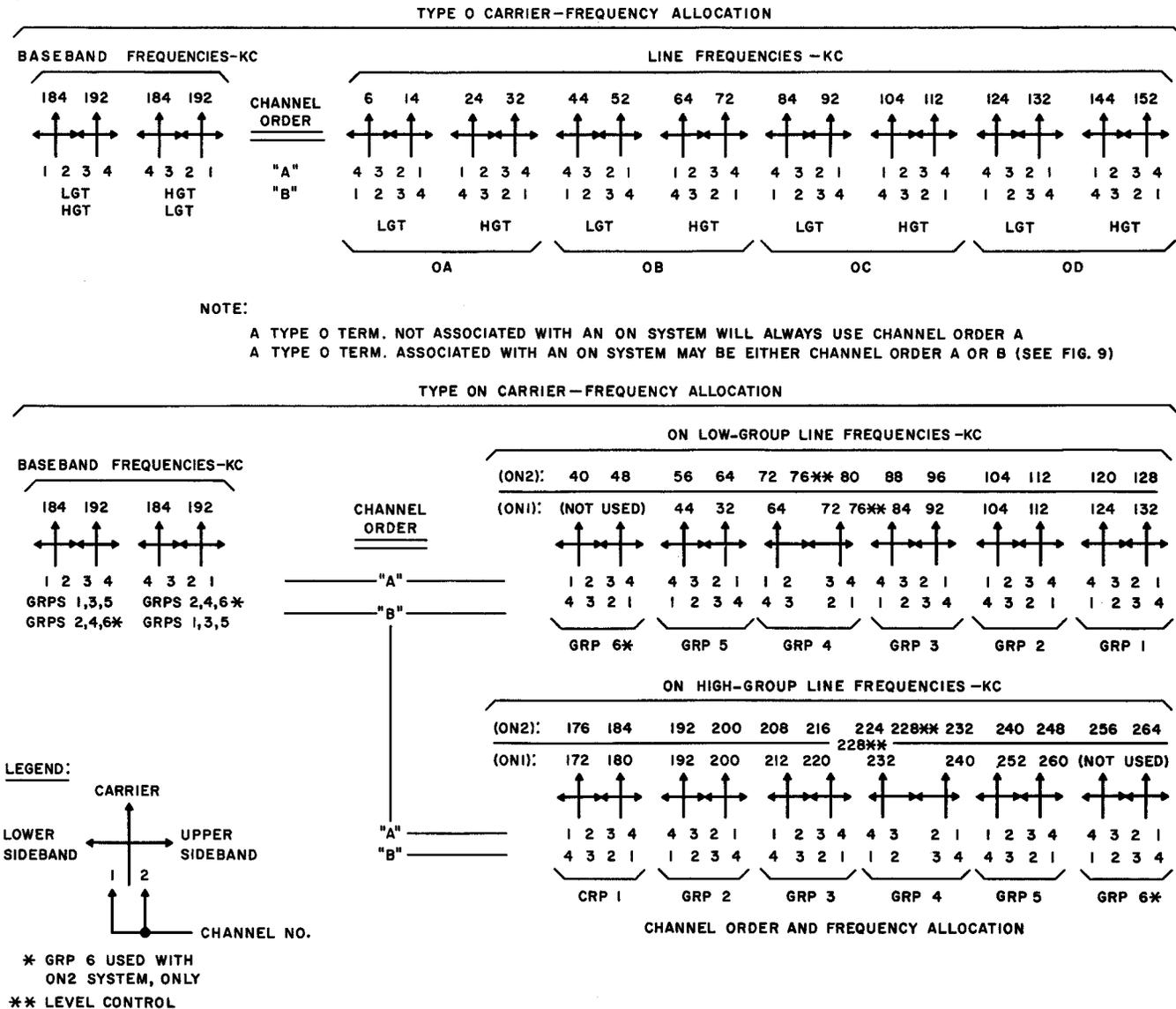


Fig. 8 — Comparison of Channel Order and Frequency Allocation in O and ON Carrier Systems

the left side, channel order B transmitting will result at the terminal on the right side. By the same analysis, for groups 1, 3, and 5, if transmitting channel order A occurs at one end, transmitting channel order B results at the other end.

2.15 If ON1 junction equipment rather than an ON terminal is located at the end of the N-type line, the channel order in the baseband at the remote open-wire O terminal will depend on whether this terminal is high-group transmit or low-group transmit. Hence, the channel order at the junction will depend on the number of intermediate frogging O repeaters.

2.16 A diagram illustrating an ON group connected to various combinations of O systems at either or both ends is shown in Fig. 10. In using this chart, the channel order is first established at one end of the system and the signal is traced through the chart to determine the resultant channel order at the other terminal. For an all-cable ON system, either terminal may follow channel order A for all groups and the other terminal will have channel order B. If any ON1 groups are carried through ON1 junction equipment and terminated in an open-wire O terminal, this O terminal ordinarily will be desig-

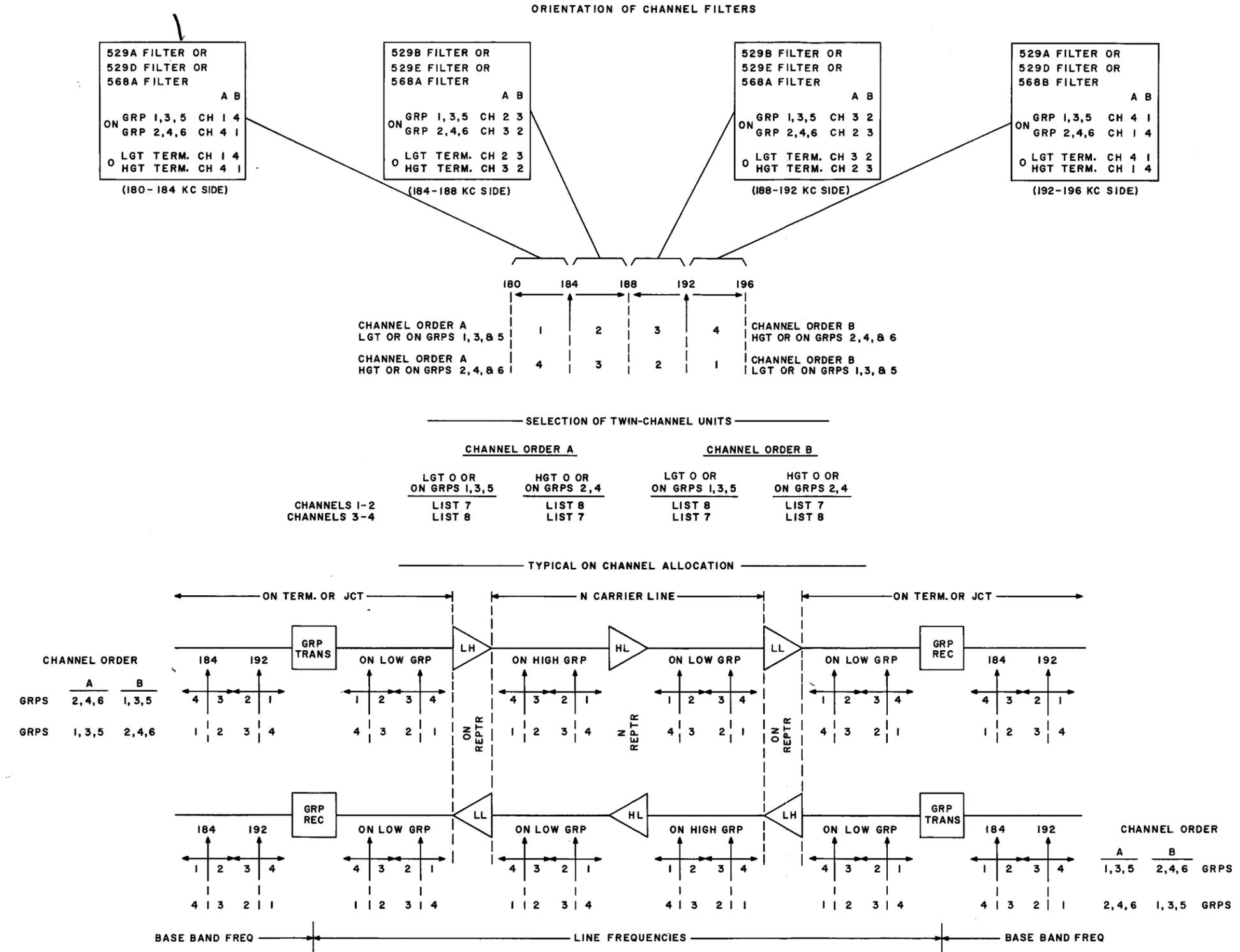
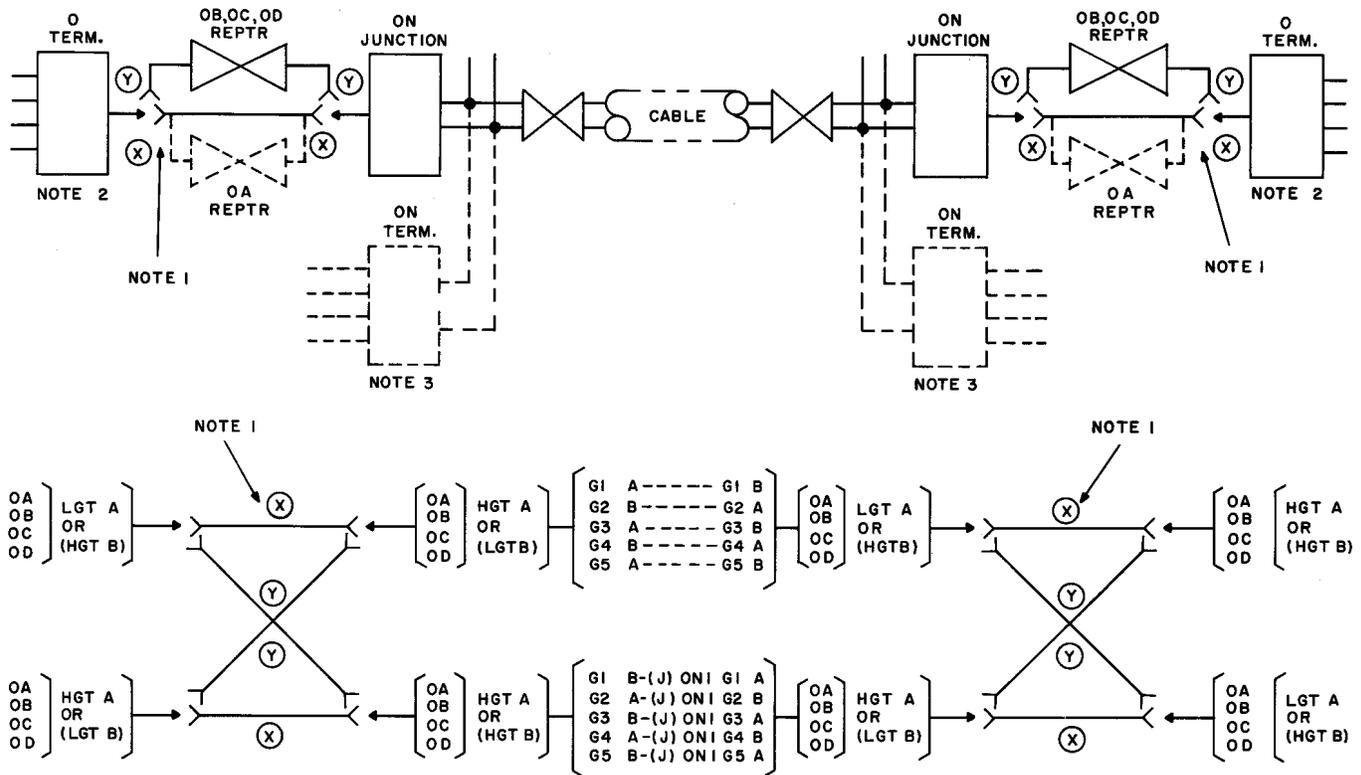


Fig. 9—Channel Filter and Twin-Channel Unit Orientation



NOTES:

1. NO INTERMEDIATE OW REPEATERS; EVEN NUMBER OF OB, OC, OR OD REPEATERS; ANY NUMBER OF OA REPEATERS. OPTION (X)
ODD NUMBER OF OB, OC, OR OD REPEATERS. OPTION (Y)
2. FOR AN ON SYSTEM INVOLVING A CABLE ON TERM. AND AN OW O TERM., THE OW TERM. IS CHANNEL ORDER A. THE CHANNEL ORDER FOR THE JUNCTION EQUIP. AND ON CABLE TERM. FOLLOW FROM CHART.
FOR AN ON SYSTEM INVOLVING 2 OW O TERMS, AND INTERMEDIATE SECTIONS OF CABLE THE OW O TERM. AT THE OFFICE HAVING THE MOST O TERMS, IS USUALLY CHANNEL ORDER A. THE CHANNEL ORDER FOR THE EQUIP. AND O TERM. AT OPPOSITE END FOLLOW THE CHART.
3. FOR ALL-CABLE ON SYSTEM, ALL 5 GROUPS AT ONE ON TERM. ARE CHANNEL ORDER A. ALL 5 GROUPS AT THE OPPOSITE ON TERM. WILL THEN BE CHANNEL ORDER B.

Fig. 10 — Determination of Channel Order (A or B)

nated as channel order A for uniformity with other O terminals that may be located in the same office. If O open-wire terminals are located at both ends with an intermediate section of cable, either terminal could be channel order A, but ordinarily this channel order will be selected for the O terminal in the office having the larger number of O terminals to obtain the maximum uniformity.

2.17 With the channel order of the terminals established, the orientation of the channel filters and the selection of the proper twin-channel unit can be determined from Fig. 9. Early 529A and 529B channel filters carried only the markings now designated as channel order A. Newer channel filters coded 529D and 529E and

also the 568-type program channel filters are marked as indicated in Fig. 9.

D. Transmission Performance

2.18 The over-all transmission performance of an ON system is comparable to that of the O or N systems. The over-all channel-frequency characteristic is controlled largely by the O-type channel and group filters, with some degradation resulting from N line transmission distortion. This distortion increases with the length of the N line.

2.19 The single sideband ON-type of transmission is not subject to amplitude distortion caused by the phase displacement of the two

sidebands which occurs in the double sideband N systems over long N lines.

2.20 Channel net loss variations of ON channels are expected to be approximately the same as those in O for a combined cable — open-wire ON system. Two factors peculiar to ON operation affect net loss variations in opposite ways and tend to nullify each other. The factor tending to improve channel net loss stability involves the employment of extra regulating circuits in ON as compared with O. These circuits are in the ON repeaters associated with the ON1 junctions and the ON terminals. For all-cable ON systems, the factor tending to degrade stability results from the use of the single sideband transmission over the N line, thereby losing the cancellation of irregularities which results from the combining, in demodulation, of the two sidebands of a double sideband N system.

2.21 Intragroup far-end crosstalk in the ON system is the same as that within an O system, resulting primarily from spillover in the channel band filters. Intragroup near-end crosstalk in an ON1 system which includes an open-wire section is similar to that in an O system, resulting primarily from modulation in the directional filters of the O terminal, O repeaters, and ON1 junction. Near-end and far-end crosstalk in O equipment is discussed in Section 362-100-100. The cable portion of an ON system is expected to contribute little to either the intragroup or the intergroup crosstalk.

2.22 Because the ON system uses transmitted carrier for demodulation, there is no overall frequency shift from voice frequency to voice frequency. There is, however, a shift in carrier frequencies over the line due to variations in the modulating oscillators in the ON terminal and the frequency-frogging oscillators in the repeaters. There are two factors in the ON system that tend to make the shift greater than in the O system: (1) It is possible to remove manufacturing variations in the crystals used in the O repeater oscillators by adjustment, but no adjustment is provided in the N- or ON-type repeaters, and (2) there will be considerably more N-type repeaters in use in an ON all-cable system than O1 repeaters used in an O system. For these reasons, wider bandpass carrier pick-off filters are used in the twin-channel units associated with both ON1 and ON2 terminals than are used in

an O system. This is also true of O1 terminals associated with an ON1 system.

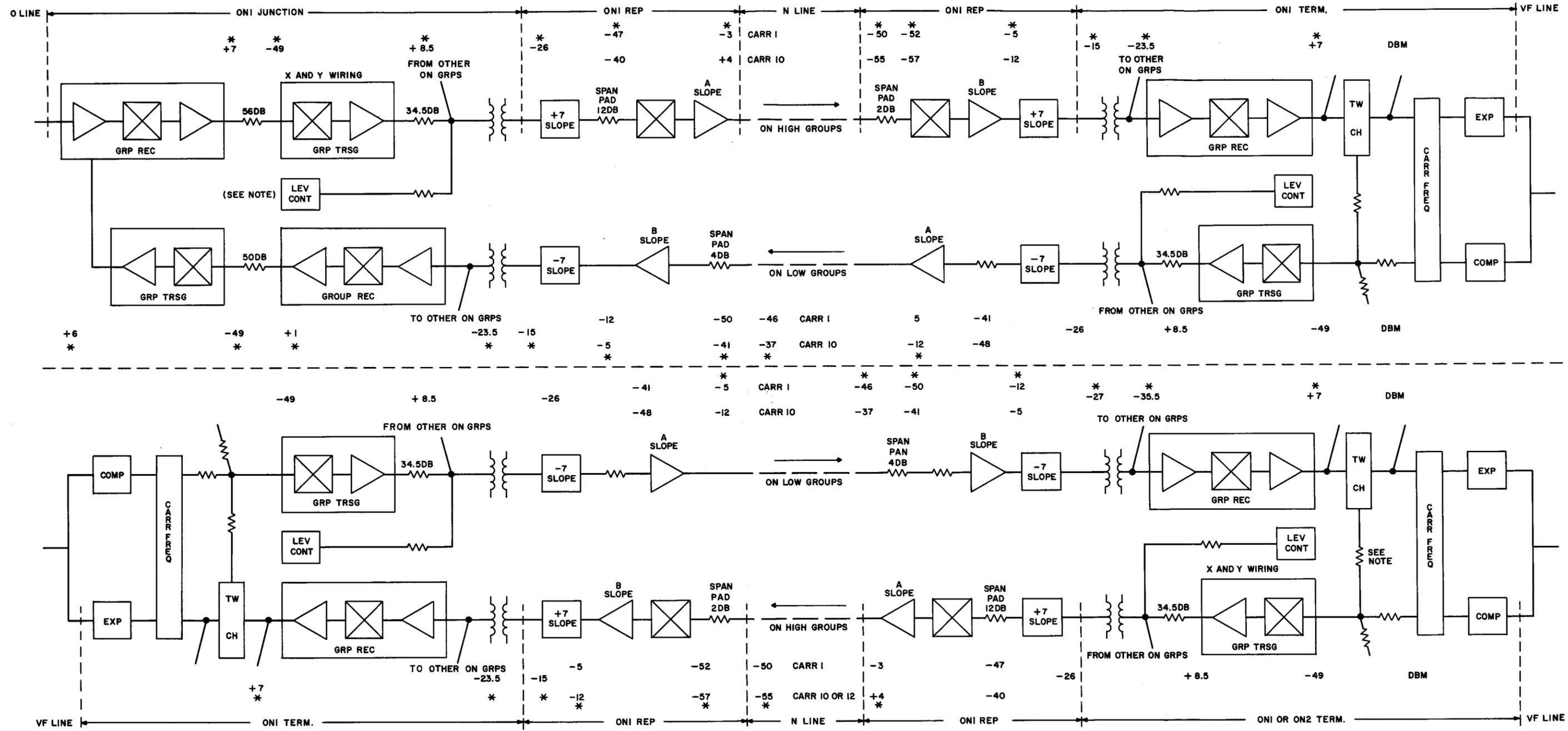
E. System Levels

2.23 To permit use of standard N-type line and N-type repeaters by the ON terminal units, the output and input levels of the ON repeaters on the carrier line side must correspond to the levels required by the N repeaters associated with the N-type line. Operational levels will, in general, correspond to standard O-type practice on the ON terminal side. The carrier-to-sideband ratio of the ON channel circuits will be unchanged from the O-type. Both the message sideband level and the signaling tone amplitude are 6 db below the channel carrier. This is because the carriers are normally transmitted to the high-frequency line at +6 dbm, and at this point the signaling tones are 0 dbm and the message level is 0 db. For the condition of a 0-dbm 1000-cycle tone at the compressor input the compressor action would cause the actual sideband amplitude to appear 3.5 db below the carrier, whereas the signaling tones would remain 6 db below the carrier. In the case of in-band signaling, the signaling tone would appear 7.5 db below the carrier on the high-frequency line during signaling conditions.

2.24 The levels given for the ON carriers in the discussion that follows are nominal values only. Because the signaling tones in each channel are only 6 db below the channel carriers, the total power is appreciably affected (1.8 db) by the presence or absence of signaling tones. The nominal level is the level obtained when half the signaling tones are on for the ON1 system. Since the regulating point of the amplifiers in the ON- and N-type repeaters is determined by the total power output, the levels of the ON carriers will vary in the system as the signaling tones are added or removed.

2.25 Level diagrams for two possible arrangements of an ON1 and ON2 carrier system are shown in Fig. 11. The level diagram for the all-cable 12-carrier ON2 system is 0.8 db lower than that of the all-cable 10-carrier ON1 system. However, for this purpose, the same level is assumed for ON1 and ON2 carrier.

2.26 Simplified schematic and level diagrams of an ON terminal and an ON1 junction are shown in Fig. 12 and 13. Each terminal and junction group transmits carriers to the associated



NOTE:

LEVEL CONTROL TONE RELATIVE TO CARRIERS AT -28 DBM POINT						
ONI	GROUPS EQUIPPED	1	1,2	1,2,3	1,2,3,5	
	RELATIVE LEV CONT TONE	+10.5	+8.5	+7	+4	
ON2	GROUPS EQUIPPED	1	1,2	1,2,3	1,2,3,6	1,2,3,6,5
	RELATIVE LEV CONT TONE	+11.5	+10	+9	+7	+4

* NOMINAL VALUES

Fig. 11 — ON Carrier Level Diagram

ON repeater at a nominal -26 dbm, and receives carriers from the ON repeater at a nominal -15 dbm.

2.27 In Fig. 12, the voice-frequency input and output for each channel is normally on a 4-wire basis. By strapping the resistance hybrid of a 4-wire terminating network in the compressor subassembly the channel unit converts from a 4-wire connection to a 2-wire connection.

2.28 The transmitting level at the 2-wire input is 0 db and the receiving level can be adjusted with the receive potentiometer from $+8$ db to -18 db, using the transmitting toll switchboard as a reference. For the 4-wire connection, the transmitting level at the input is -16 db and the receiving level can be adjusted from $+10$ db to -16 db.

2.29 In Fig. 13, the output of the group receiving circuit CA unit at an ON1 junction is $+1$ dbm. This is 6 dbm below standard levels at O and ON terminals and is for the purpose of obtaining an adequate regulating range.

2.30 Nominally, the carrier powers at the open-wire side of the junction are the same as in a standard O system. The levels that may be encountered on a typical O-type line are shown in Fig. 14.

2.31 A level diagram of the ON carriers on a typical N-type line between ON terminals or between an ON1 terminal and an ON1 junction, including ON repeaters at either end, is shown in Fig. 15. Although only an LH-LL and an HL-LL repeater are shown, similar levels would apply for other ON repeaters.

2.32 The purpose of slope networks and the slope switch on the ON repeater in the transmitting side is to preslope the carriers in the cable section so that the high frequencies are transmitted at a higher level than the lower frequencies. This is usually half the nominal slope of the cable section. In the receiving side, they equalize the other half of the slope so that the level of the carriers supplied to a junction or terminal is the same. This is done to permit the use of a standard N line. Slope settings A, B, and C are provided in ON repeaters, as in N repeaters.

3. EQUIPMENT DESCRIPTION AND OPERATION

A. General

3.01 The N cable and the N repeaters used with the ON1 and ON2 systems are standard equipment and do not require modification. The O-type equipment which is used in ON1 and ON2 terminals and ON1 junctions consists of both standard and modified units. The ON repeater is a modified N repeater. The modified units appear the same physically and are used in the same general manner as corresponding O- and N-type units.

3.02 O-type equipment is modified for use in ON systems to provide 4-wire transmission, to permit the terminal and junction to both transmit and receive low-frequency groups, and to provide wider pick-off filters for the greater carrier-frequency deviations encountered in ON systems. Modification of the N repeater for use as an ON repeater is required to permit the terminal and junction to both transmit and receive low-frequency groups. In addition, the ON2 terminal groups require greater filtering than the ON1 terminal groups to provide the group separation required to permit the elimination of the between-group spacings provided in the ON1 system. Both the ON terminal and junction groups eliminate the directional filters which are used with O-type groups, while increasing the suppression characteristics of the auxiliary filters.

B. ON Terminals

3.03 A complete ON terminal consists of five (ON1) or six (ON2) modified O1 terminals and a combining network and oscillator panel to combine the ON groups. In the event of partially equipped groups, an oscillator provides a level-control tone to provide the missing carrier power for proper level regulation in the repeated line. Each terminal is designed to terminate a 4-channel ON group and occupies a vertical bay space of $24\frac{1}{2}$ inches (fourteen $1\frac{3}{4}$ inch mounting-plate spaces). A simplified block schematic of one group of an ON terminal is shown in Fig. 16.

3.04 The combining network and oscillator panel, shown in Fig. 17, mounts a resistance multiple for combining the transmission outputs of up to six groups and the output of the level-control oscillator. The unit also mounts a transformer for providing a balanced output to the ON repeater (not provided on early units), an impedance-matching transformer for combining the receiving inputs, and a jack into which is plugged the level-control oscillator unit. In addition, jacks and potentiometer are provided to set the output of the level-control oscillator. The combining network and oscillator panel occupies a vertical bay space of 3-1/2 inches (two 1-3/4 inch mounting-plate spaces).

3.05 The modified O1 terminal shown in Fig. 18 contains four O-type channel units; two twin-channel units; receiving-, transmitting-, and oscillator-group units; and a fuse panel. The four channel units are standard O-type units, while the twin-channel units have been modified by replacing the 100-cycle wide O1 carrier pick-off filter with an ON filter having a wider bandpass capability (200 cycles). The wider bandpass is required to accommodate the greater shifts in carrier frequency resulting from the larger number of repeaters in the N line. A comparison of O-type and ON-type filter characteristics is shown in Fig. 19.

3.06 The transmitting-group unit is a standard O-type unit. The oscillator-group unit is also standard except for output strapping which supplies the same frequency to both transmitting- and receiving-group units. The receiving-group unit differs from a standard O-type unit in the plug-in filters used. Also, because transmitting and receiving on the cable side of the terminal is on a 4-wire basis, no directional filter is required. Therefore, the directional filter is replaced with a connecting plug which substitutes direct connections in place of the directional filter. Omission of straps on the terminal mounting normally used for O carrier system provides access to the transmitting-group unit on a 4-wire basis. The auxiliary filters, mounted in the same can with the receiving bandpass filters, are standard O-type filters.

3.07 The transmitting outputs of the ON groups are combined in a resistance-multiple pad mounted on the combining network and oscillator

panel. The combining multiple provides impedance matching between the 135-ohm outputs of the transmitting-group units and the 135-ohm input of the ON repeater. It serves the further purpose of providing isolation between transmitting groups to reduce the level of intermodulation products formed in one unit by the outputs of the other units. The through loss of the combining multiple is 34.5 db, so that the loss between transmitting groups is 69 db, which is sufficient to reduce intermodulation products to a negligible level. A transformer, not provided in earlier equipment, furnishes a balanced input to the ON repeater.

3.08 The receiving inputs of the ON groups are combined by simply paralleling them. An impedance-matching transformer, mounted on the combining network and oscillator panel, provides an impedance match between the 135-ohm impedance of the ON repeater output and the 22.5- or 27-ohm impedance of the paralleled ON2 or ON1 receiving-group inputs. Except in earlier models, this transformer is balanced on the 135-ohm side.

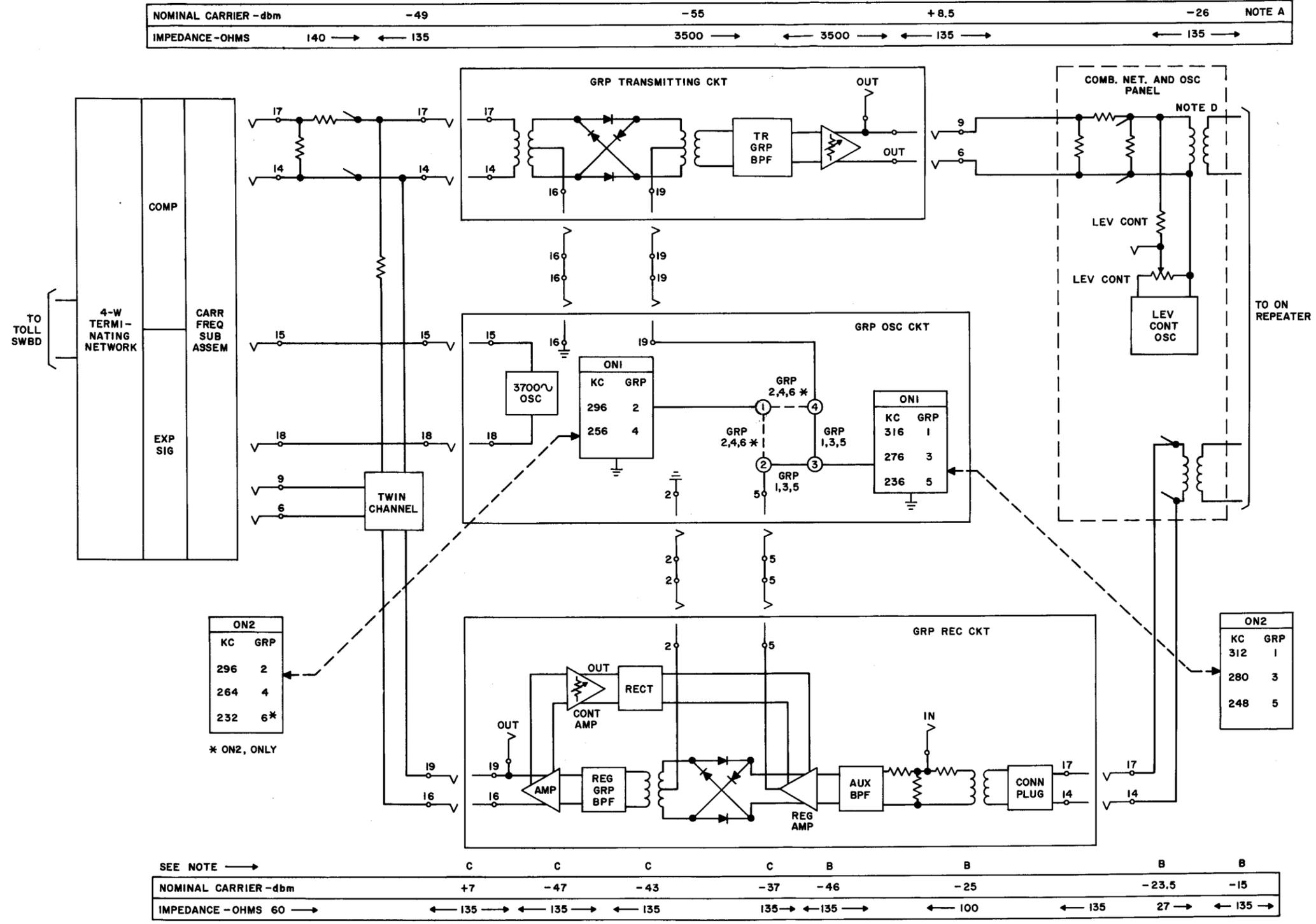
3.09 The level-control oscillator is also mounted on the combining network and oscillator panel. It is similar to a standard O1 repeater oscillator and is the same as the 76-kc oscillator used in the ON1 junction.

3.10 The function of the controls and adjustments in an ON terminal is the same as in an O1 terminal. For a discussion of these controls and adjustments refer to Section 362-100-100.

C. ON Repeaters

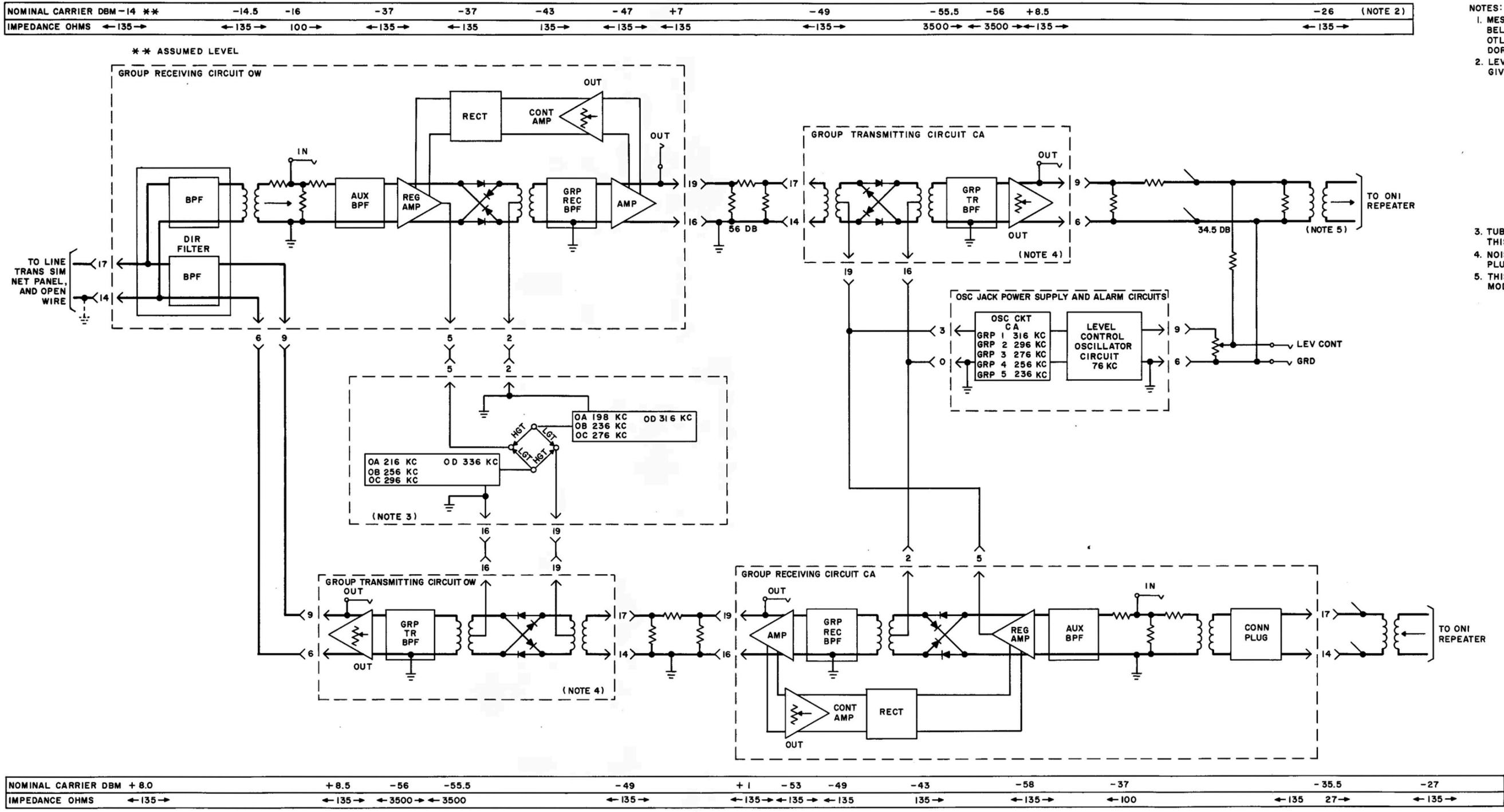
3.11 Although identical in appearance to N repeaters, the ON repeater contains a circuit modification in one subassembly that enables it to fit into the ON system modulation plan.

3.12 Each ON repeater consists of a standard N oscillator and power subassembly, a standard N LH or HL, E-W or W-E modulator and amplifier subassembly, and a modified LL, W-E or E-W amplifier subassembly. These three



- NOTES:
- A. LEVEL CONTROL POWER IN DBM AT THIS POINT IS GIVEN IN THE FOLLOWING TABLE:
- | GROUPS EQUIPPED AND CORRECT ORDER TO EQUIP THEM | LEVEL CONTROL POWER (dbm) TO BE ADDED | |
|---|---------------------------------------|--------|
| | ON1 | ON2 |
| 1 | -17.5 | -16.4 |
| 1,2 | -19.5 | -17.9 |
| 1,2,3 | -21.0 | -18.8 |
| 1,2,3,5 (ON1 ONLY) | -24.2 | — |
| 1,2,3,5,4 (ON1 ONLY) | NO LCO | — |
| 1,2,3,6 (ON2 ONLY) | — | -21.0 |
| 1,2,3,6,5 (ON2 ONLY) | — | -24.0 |
| 1,2,3,6,5,4 (ON2 ONLY) | — | NO LCO |
- B. NOMINAL VALUE: IF ALL SIGNALING TONES OF ALL GROUPS ARE OFF, CARRIERS ARE 1db HIGHER; IF ALL TONES ARE ON, CARRIERS ARE 1db LOWER.
- C. NOMINAL VALUE: IF ALL SIGNALING TONES OF THIS GROUP ARE OFF, CARRIERS ARE 1db HIGHER; IF ALL TONES ARE ON, CARRIERS ARE 1db LOWER.
- D. THIS TRANSFORMER NOT FURNISHED ON EARLIER MODELS.

Fig. 12 — Levels and Controls — ON Carrier Terminal



- NOTES:
1. MESSAGE LEVEL AND SIGNALING POWER IN DBM IS 6 DB BELOW CARRIER AT EACH POINT. 0 DBM TEST TONE AT OTL IS 3.5 DB BELOW CARRIER LEVEL WITH COMPAN-DORED CHANNELS.
 2. LEVEL CONTROL POWER IN DBM AT THIS POINT IS GIVEN IN FOLLOWING TABLE:

GROUPS EQUIPPED	LEVEL CONTROL
1	-17.5
1,2	-19.5
1,2,3	-21.0
1,2,3,5	-24.2
1,2,3,5,4	NOT USED
1,2,3,6	---
1,2,3,6,5	---
1,2,3,6,5,4	---

3. TUBES REMOVED FROM 3700 CYCLE OSCILLATOR IN THIS APPLICATION.
4. NOISE GENERATOR TUBE REPLACED WITH SHORTING PLUG
5. THIS TRANSFORMER NOT FURNISHED ON EARLIER MODELS.

Fig. 13— Levels and Controls— ON1 Junction

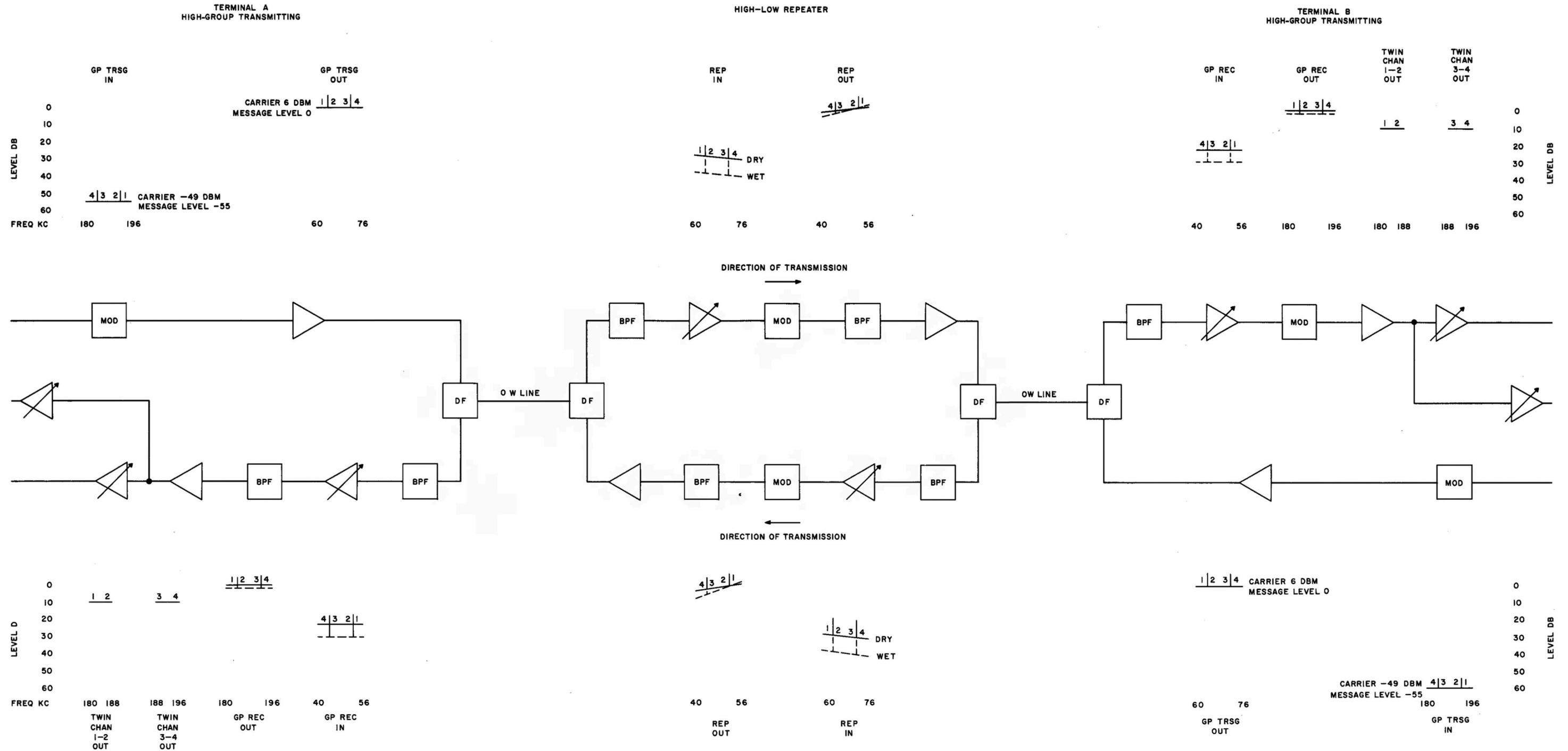
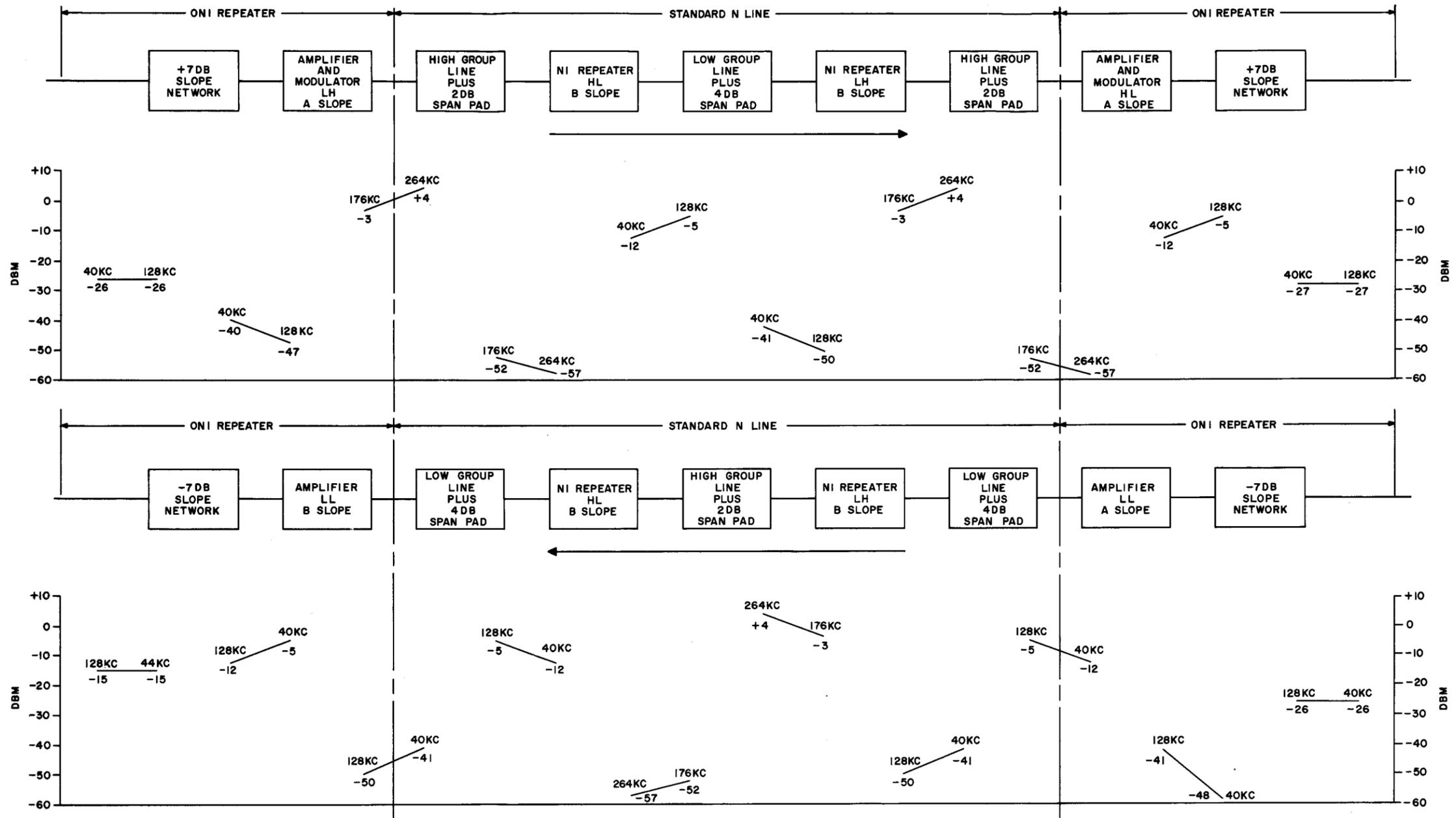


Fig. 14— Level Diagram for Typical OB System



- NOTES:
1. ALL GROUPS ARE ASSUMED TO BE EQUIPPED.
 2. GROUP ONE CARRIERS ARE AT 120-128KC, GROUP FIVE CARRIERS ARE AT 40-48KC.
 3. LEVELS SHOWN ARE NOMINAL FOR INPUTS AND OUTPUTS OF TRANSMITTING SLOPE NETWORKS CONNECTED TO ON2 TERMINALS. OTHER LEVELS SHOWN ARE APPROXIMATE - IF ALL SIGNALING TONES OF ALL GROUPS ARE OFF CARRIERS ARE 1 DB HIGHER. IF ALL SIGNALING TONES OF ALL GROUPS ARE ON, CARRIERS ARE 1DB LOWER.
 4. MESSAGE LEVEL AND SIGNALING POWERS ARE 6DB BELOW CARRIERS.
 5. FREQUENCIES SHOWN ARE FOR ON2 CARRIER SYSTEM. ON1 SYSTEMS HAVE A LOW-GROUP FREQUENCY BAND OF 44-132KC AND A HIGH-GROUP BAND OF 172-260KC.

Fig. 15 — Typical Level Diagram for ON2 System Over N-Type Line Including ON Repeaters

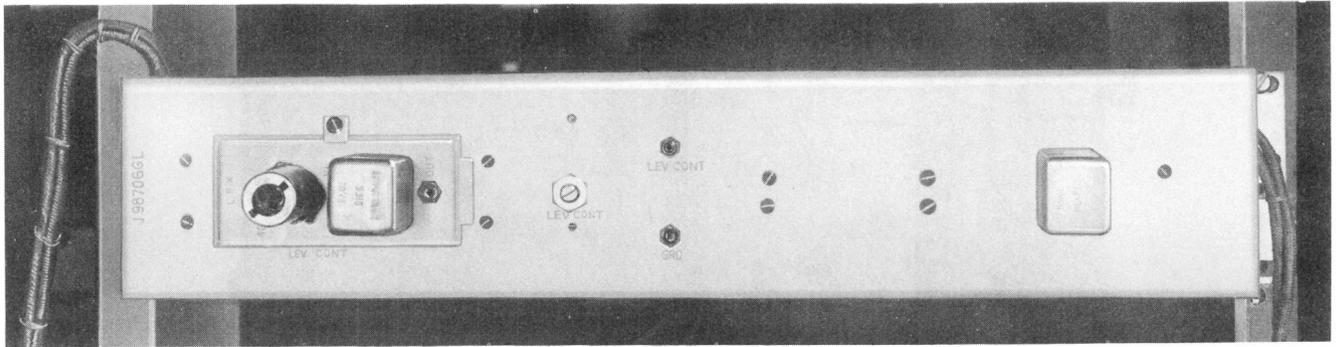


Fig. 17 — Combining Network and Oscillator Panel

subassemblies are shown for one direction of transmission, in a simplified block schematic, Fig. 20.

3.13 The LL, W-E or E-W amplifier subassembly is essentially a modification of the LH or HL repeater section that has been modified to omit the modulator and to add the necessary filters and padding to the amplifier. A +7 db slope network is associated with the HL or LH subassembly of the ON repeater and a -7 db slope network is associated with the LL subassembly. This slope network is mounted on a tenite strip assembly attached to the repeater mounting bracket and is used between the ON1 junction or ON terminal and the ON repeater. In early models of the ON repeater the unbalanced -7 db slope network was incorporated into the modified subassembly and was located at the side of the ON repeater adjacent to the ON terminal or ON1 junction. The slope networks are defined in terms of their effect on output levels in Fig. 21.

3.14 A complete description of ON repeaters and their operation is provided in circuit descriptions CD-95192-01, CD-95193-01, CD-95194-01, and CD-95195-01.

D. ON1 Junction

3.15 An ON1 junction is the transition point between open-wire O systems and ON1 cable facilities. The junction consists of a framework mounting standard O1 receiving-group, transmitting-group, and oscillator units on the open-wire side of the junctions and standard O1 transmitting-group units, modified O1 receiving-group units, and modified repeater-oscillator units on the cable side of the junction.

3.16 Three junction mounting frameworks are required for a complete 5-group, 20-channel ON1 system. The equipment for group 1 and some equipment for groups 3 and 5 plus equipment common to all five groups is mounted on one junction framework. This junction is designed specifically for group 1 equipment. The additional equipment required for groups 2 and 3 and groups 4 and 5 is mounted on two similar junction frameworks.

3.17 A typical equipment arrangement of a 20-channel ON1 junction is shown in Fig. 22. Other arrangements are possible as groups 2, 3, 4, and 5 may be mounted in any of the junction-mounting positions except the positions provided for group 1 equipment.

3.18 The units that plug into the junction mountings are designated by the ON group number, their function, and whether they are associated with the open-wire or cable side of the junction. Typical designations are GRP 1 REC CA and OSC 1 OW.

3.19 In addition to the jacks for the plug-in units, the junction mounting for group 1 contains a potentiometer and jacks for setting the level-control oscillator output; terminal strips for making interconnections; transmission loss pads and the ON1 group combining pad; a transformer for matching impedances in the receiving line on the cable side of the junction; and a transformer for providing balanced output to the repeater on the cable side of the combining multiple (this transformer was not provided in earlier equipment). A junction-mounting framework for

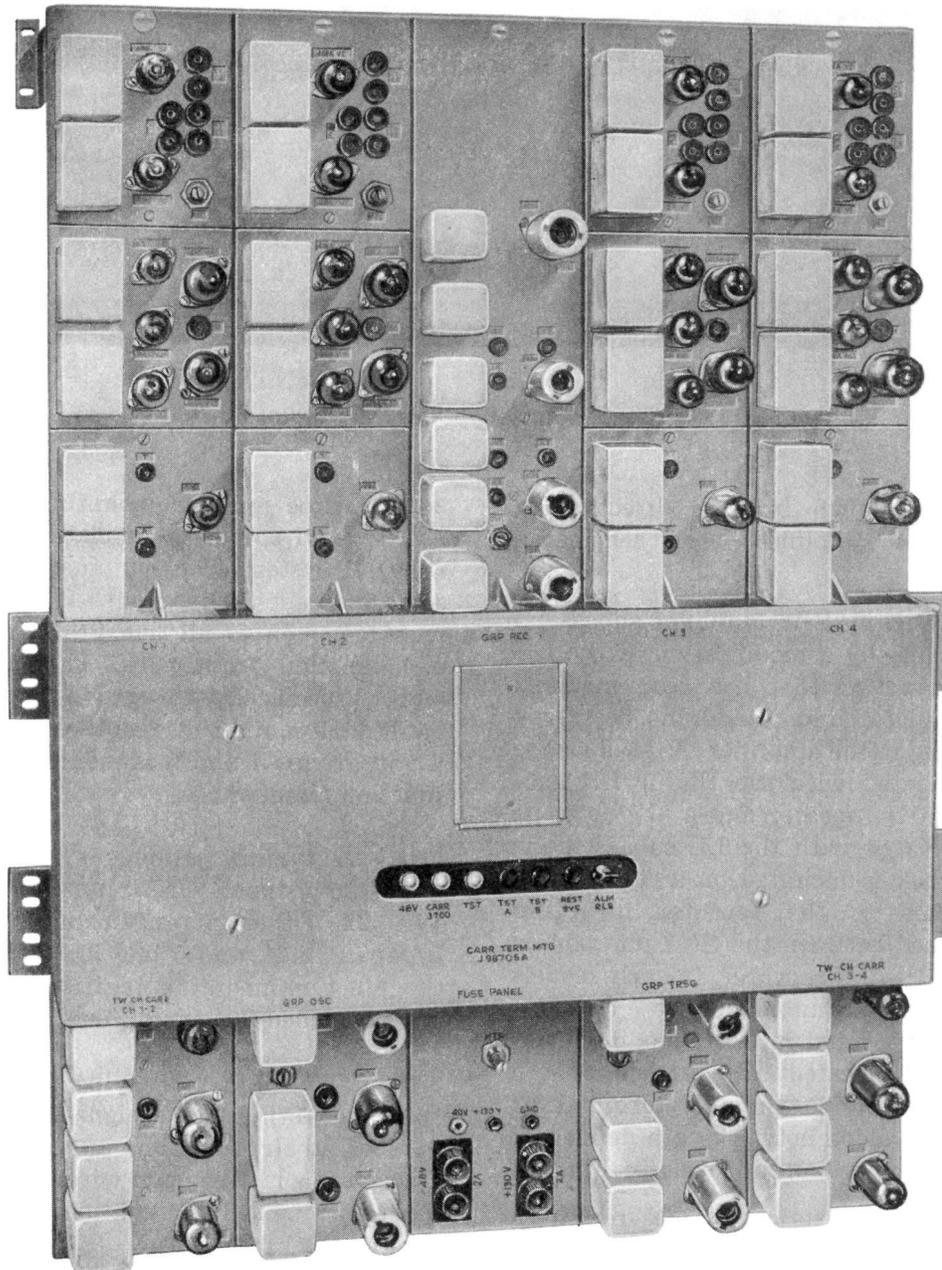


Fig. 18 — ON1 Terminal Group

ON1 group 1 is shown in Fig. 23; an ON1 junction group 1 with the plug-in units in place is shown in Fig. 24.

3.20 The mounting frameworks for groups 2, 3, 4, and 5 are identical. In addition to the jacks for the plug-in units, they are equipped with terminal strips, for making interconnections,

and transmission loss pads required between the receiving- and transmitting-group units. A typical ON1 junction for any two groups of groups 2, 3, 4, and 5 is shown in Fig. 25.

3.21 Each junction mounting occupies a vertical bay space of 22-3/4 inches (thirteen 1-3/4 inch mounting-plate spaces). The line transformer

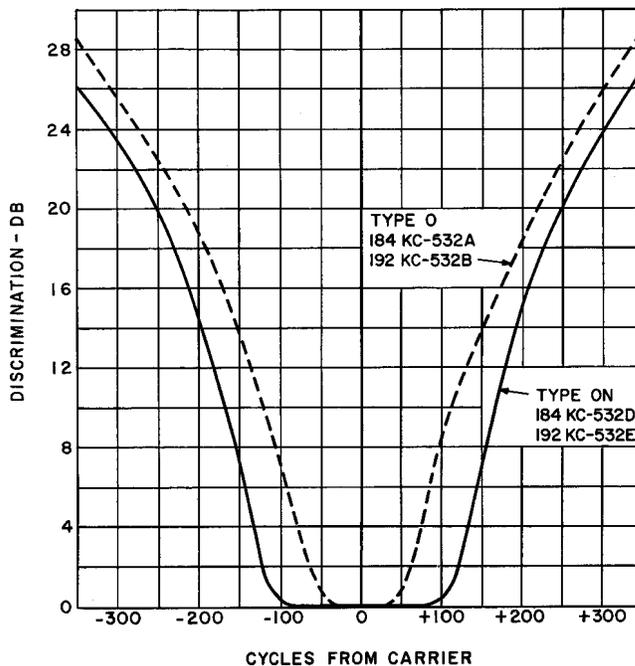
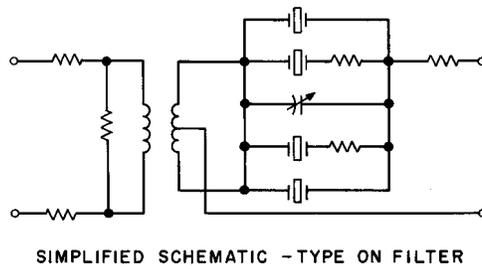


Fig. 19 — O- and ON-Type Carrier Pick-Off Filter Characteristics

and network or line-jack circuits that are associated with the open-wire side of the junction are mounted separately.

3.22 The junction arrangements described are standard for a complete junction when all five 4-channel groups from the cable are extended on open wire as five O systems. In an installation where some groups are extended and others terminated, ON1 terminal groups are combined with ON1 junction groups as required. In this type installation, group 1 is always used for one of the groups extended on open wire, since the combining panel and level-control oscillator are provided for in this mounting.

3.23 A block schematic of one group of an ON1 junction is shown in Fig. 26. The inputs and outputs of from one to five similar groups on the cable side are multiplied on a 4-wire basis as indicated in the figure. The interconnections on the open-wire side of the junction are determined by the arrangement of O systems to which the junction connects. On the open-wire side the junction groups are treated as O1 terminals. Reference should be made to Section 362-100-100 for a detailed discussion. The open-wire systems may be assigned freely to the junction groups, except that an OA HGT should not be assigned to group 4 of the junction if an OB HGT on the same open-wire pair is assigned to any other group of the same junction. This particular combination might adversely affect the carrier alarms.

Open-Wire Side of Junction

3.24 The equipment on the open-wire side of the junction consists of the GRP REC OW, GRP TRSG OW, and GRP OSC OW units. These units are standard O1 units with no modifications. The filter codes and oscillator frequencies are shown in Fig. 26.

Cable Side of Junction

3.25 The equipment on the cable side of the junction consists of the GRP REC CA, GRP TRSG CA, and OSC CA units. The level-control oscillator and the impedance-matching transformers are contained in the group 1 equipment. The transformer on the receiving side matches the 135-ohm impedance of the ON repeater to the 27-ohm parallel impedance of the five GRP REC CA units. The transformer in the transmitting side (except in the earlier systems) provides a balanced circuit for the slope network and ON repeater.

3.26 The GRP TRSG CA unit is a standard O1 transmitting-group unit. Since the same frequency is supplied to both the transmitting- and receiving-group units, the group oscillator (OSC CA) is an O1 unit strapped so that the same frequency is supplied to both units. Since the cable side is on a 4-wire basis, no directional filter is required. The GRP REC CA unit is a standard O1 receiving-group unit with the directional filter replaced by a connecting plug and

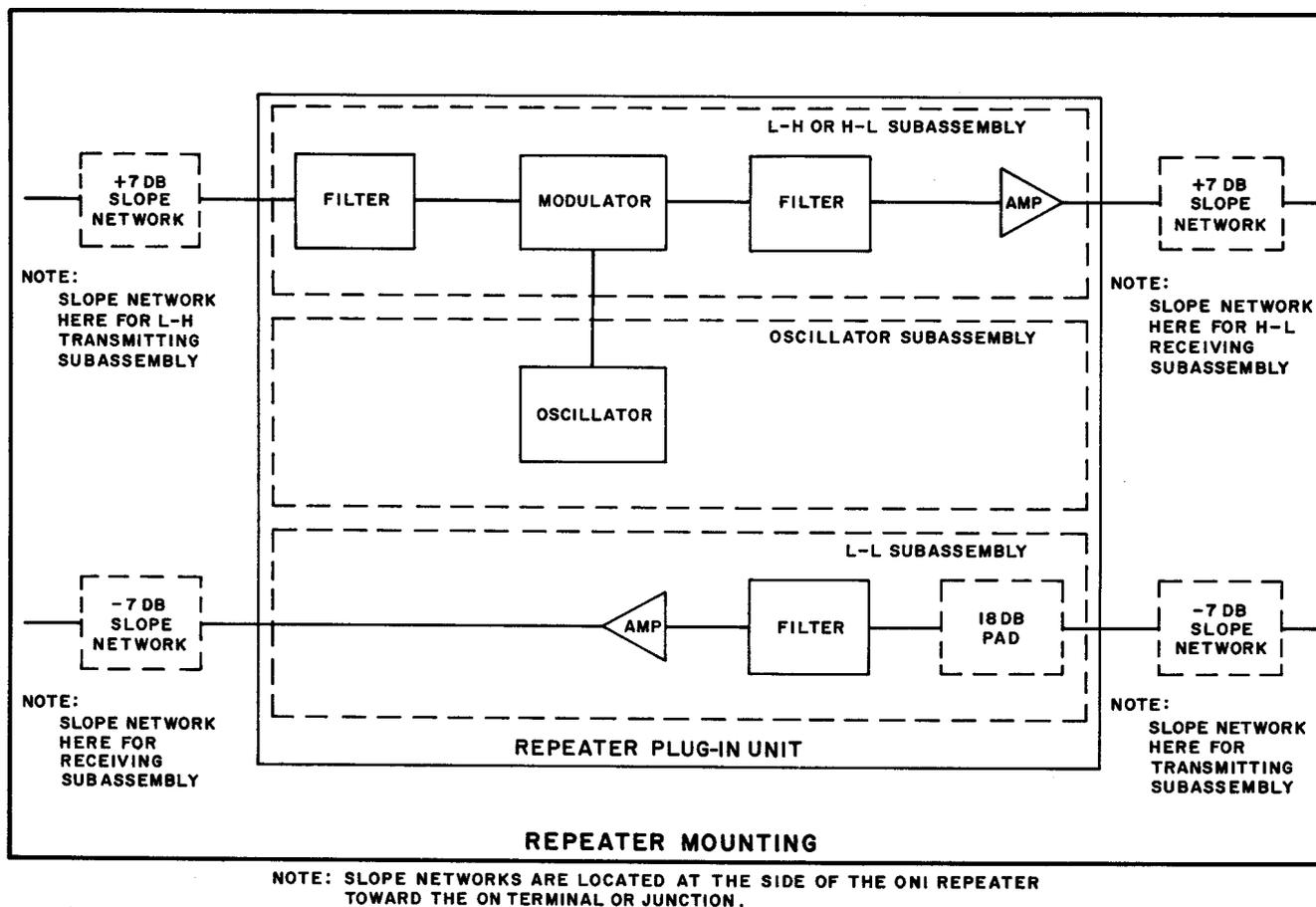


Fig. 20 — ON Repeater Schematic

with the plug-in auxiliary filters replaced. The connecting plug substitutes direct connections in the position normally occupied by the receiving side of the directional filter.

Controls and Adjustments

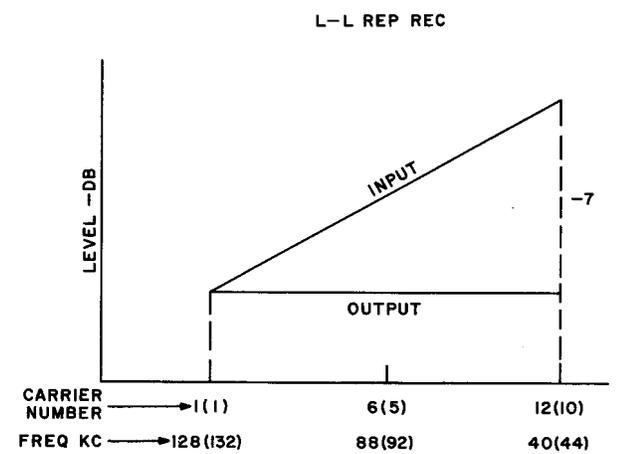
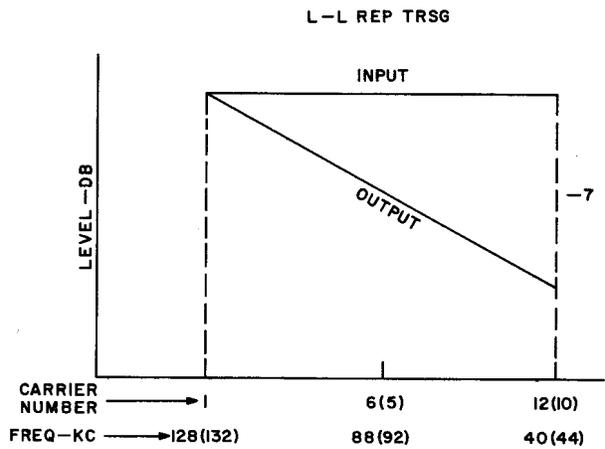
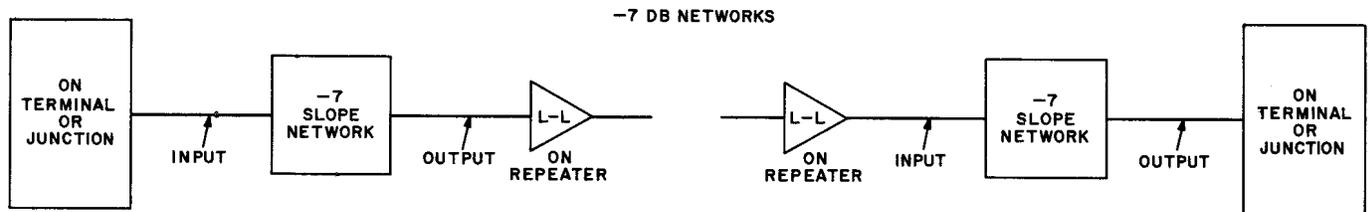
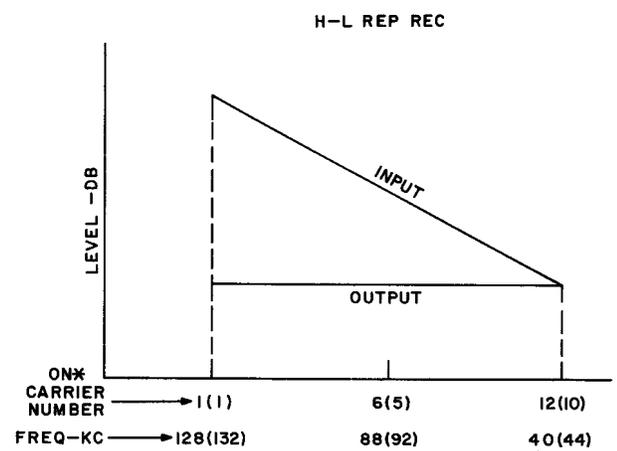
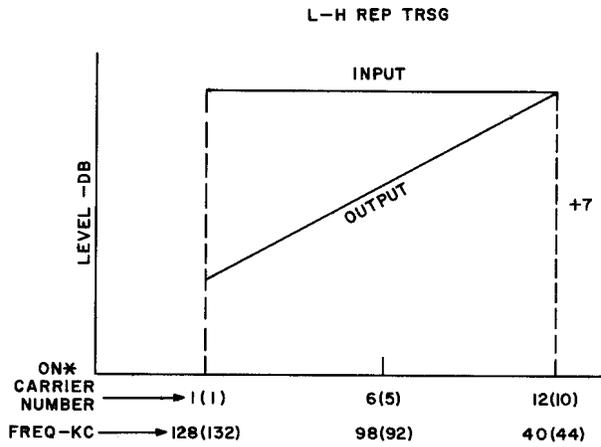
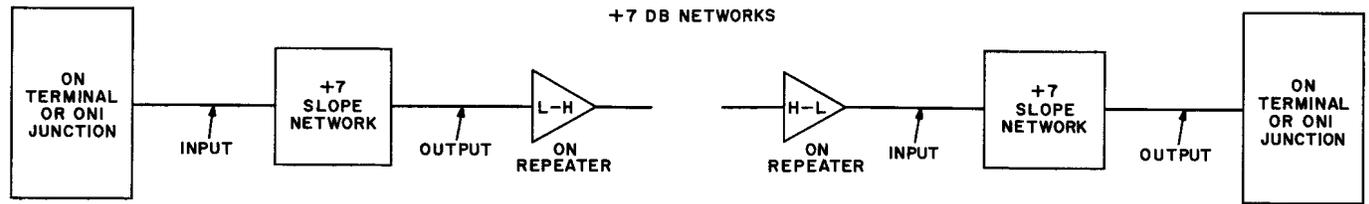
3.27 The OUT controls in the GRP REC OW unit and in the GRP REC CA unit are used to adjust the total carrier power to the correct level. These adjustments affect the 4-channel group and its two carriers. Fig. 13 provides a diagram showing the levels and controls throughout an ON1 junction. The values of +1 dbm for the GRP REC CA unit and +7 dbm for the GRP REC OW unit shown in this diagram are for each carrier.

3.28 The OUT control (X and Y wiring) in the GRP TRSG CA or GRP TRSG OW units is used to provide the proper output for an in-

dividual group to the ON repeater or to open wire, respectively. For coordination with other systems in the same cable or on the open wire, a wiring option (Y) provides greater range for the OUT control.

3.29 The 76-kc level-control oscillator provides a means of keeping the total power to the ON repeater constant for cases of partially equipped junctions. The LEV CONT potentiometer adjusts the 76-kc tone to the proper magnitude.

3.30 On the open-wire receiving side of the junction, sufficient regulation range is provided in the receiving equipment to permit operation with input carriers as indicated in Section 362-100-100.



* PARENTHETICAL NUMBERS APPLICABLE TO ONI SYSTEM ONLY.

Fig. 21 — Slope Networks at ON Repeaters

SECTION 362-100-150

3.31 The noise generator located in the transmitting-group unit is not required at a junction. If noise is required to mask low-level intelligible crosstalk, it will be inserted at the receiving open-wire and cable terminals. The electron tube in the noise generator is replaced with a 393A-type plug in an ON1 junction.

3.32 The output of the 3700-cycle oscillator in the GRP OSC OW is not required at the junction. The electron tube is therefore not required. It may be removed without opening a heater circuit.

E. Power Supplies

3.33 The terminals and junctions require dc power at -48 and +130 volts. The locally powered repeaters require a +130 volt supply only. To supply power to an adjacent repeater, both +130 and -130 volt supplies are required. Each terminal, junction, and repeater is equipped with alarm-type fuses for heater and plate circuits. Power requirements for terminal groups, junction groups, and repeaters are as follows:

-48 Volts +130 Volts

Maximum current per ON terminal (4 channels):

Group 1	1.80 amps	0.500 amp
Groups 2-6	1.75 amps*	0.450 amp**

Maximum current per junction:

Group 1	0.55 amp	0.169 amp
Groups 2-6	0.50 amp	0.164 amp

Current per level-control oscillator

	0.05 amp	0.008 amp
Current per repeater		0.17 amp

Note: Where power is supplied through an ON repeater and over the cable to an adjacent N repeater there will be an additional drain of 0.17 amp at +130 volts and 0.17 amp at -130 volts for each ON repeater.

*This current drain could reach 1.94 amps maximum under alarm conditions.
 **This current drain could reach 0.492 amp maximum under alarm conditions.

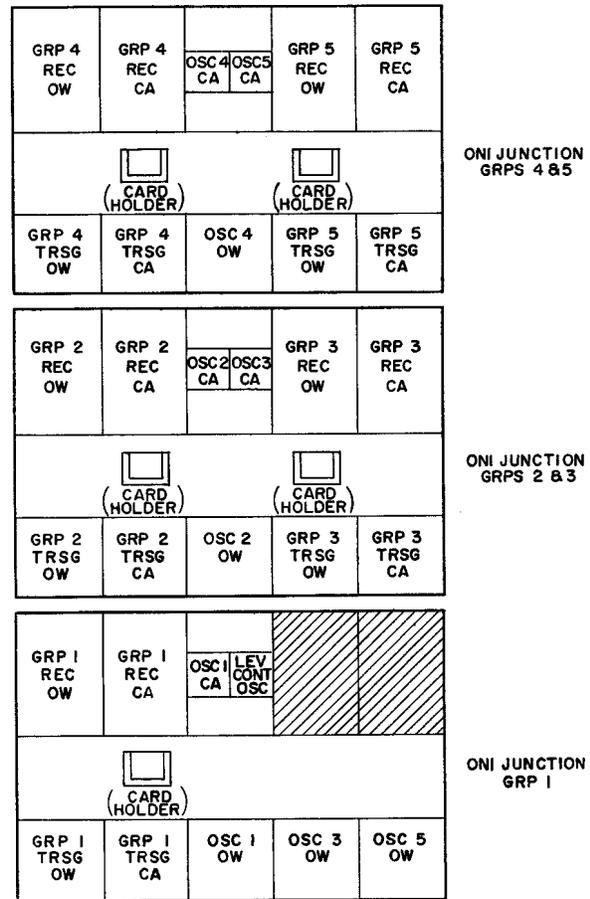


Fig. 22 — Arrangement of 20-channel ON1 Junction Equipment

ON1 Junction Power Supply

3.34 Power for the ON1 junction comes from three supplies. One supply furnishes group 1, the other two furnish groups 2 and 3, 4 and 5. Each is an adaptation of the O1 repeater power supply. A schematic diagram of a junction power supply is shown in Fig. 27.

3.35 Power to the ON1 junction is obtained through the Hubbel plug and receptacle from the +130 and -48 volt office batteries or power supplies. Plate battery for the junction passes through two fuses, the two halves of inductor L1, and the junction frame plug and jack assembly. Inductor L1 and capacitors C1 and C2 provide plate-battery filtering. In a group 1 junction, one lead goes to the group circuits including

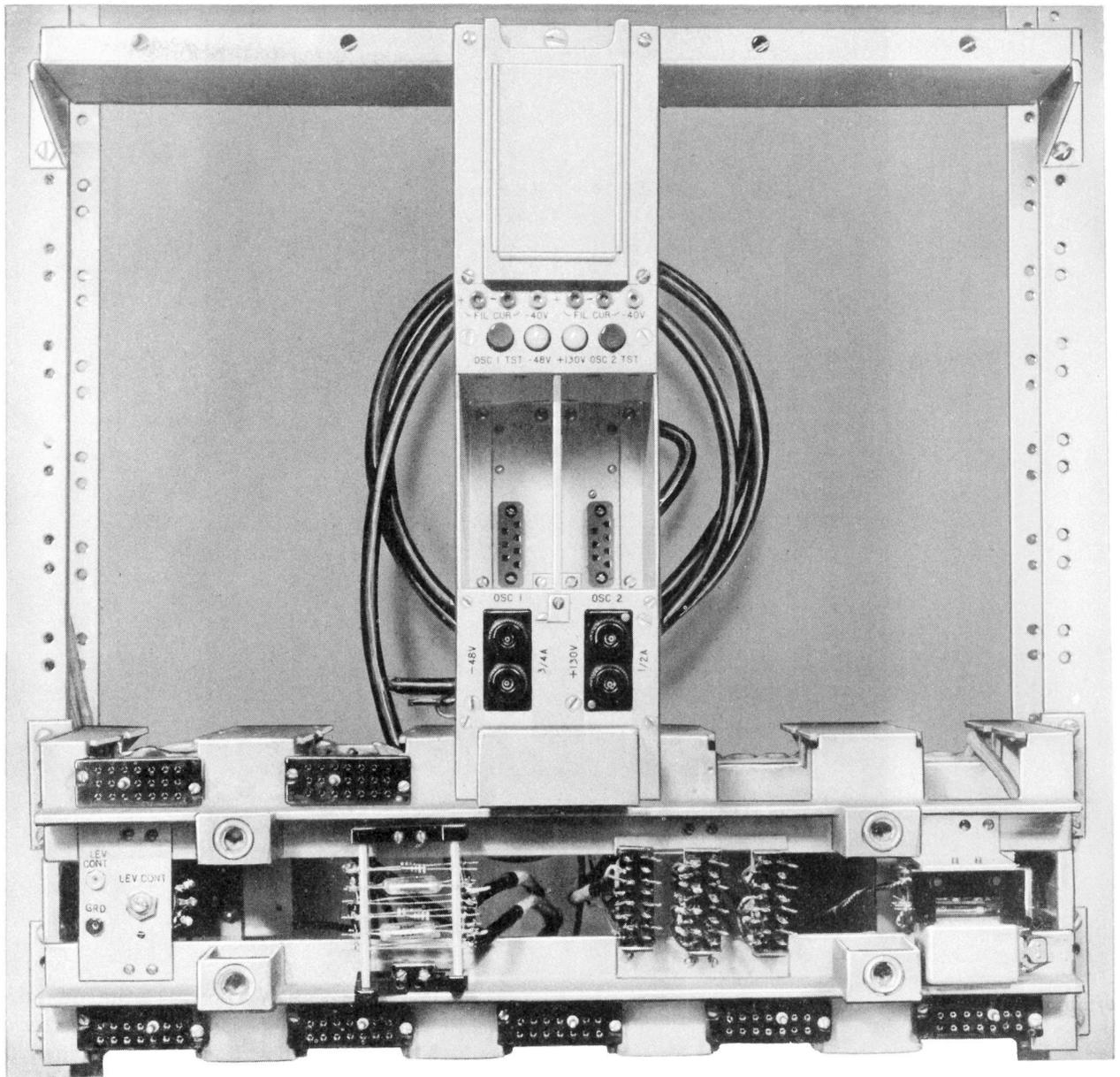


Fig. 23 — Junction-Mounting Framework — Group 1

the associated oscillator, and the second lead to the level-control oscillator. In groups 2, 3, 4, and 5, one lead goes to the group mounted on the left side of the junction mounting, the other to the group on the right. The -48 volt power is distributed from the plug and jack assembly in the same manner as the plate supply. As indicated in Fig. 27, certain apparatus furnished in the plug-in power unit is removed in this application.

3.36 The heater circuit in the junction requires a -38.5 volt battery. To obtain this battery voltage from the -48 volt supply, voltage-dropping rheostats 48V FIL (1), 48V FIL (2), and FIL CUR (2) are provided. These rheostats are adjusted with all junction circuits in position so that the voltage measured at the $-40V$ (1) and $-40V$ (2) test jacks is 38.5 volts when the -48 volt supply is at its average value.

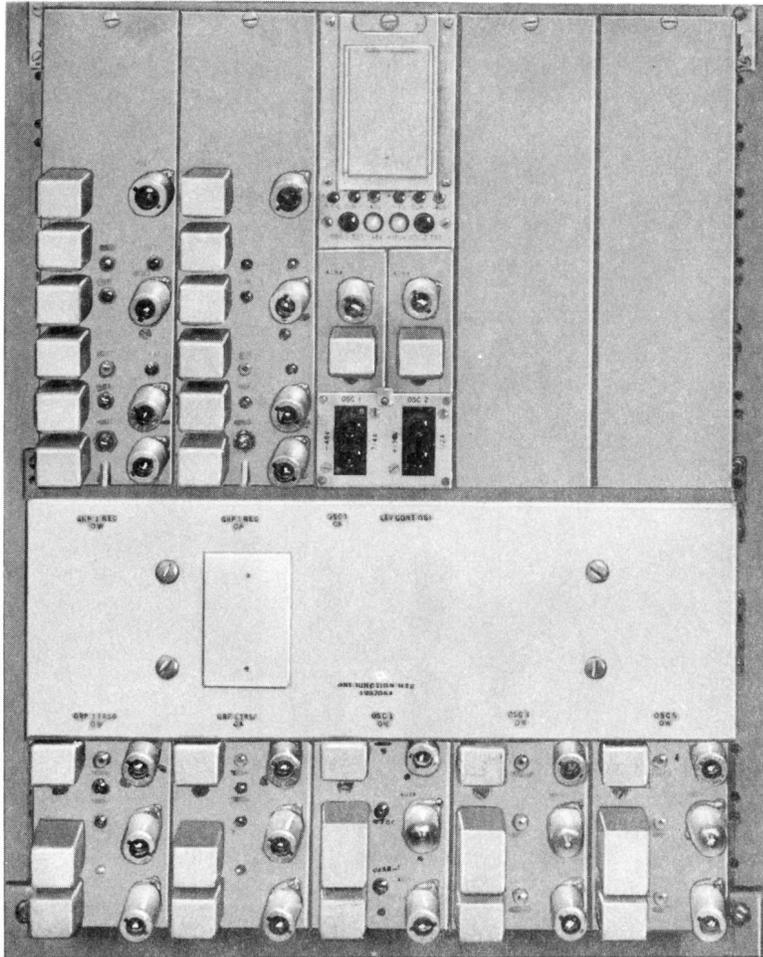


Fig. 24 — ON1 Junction — Group 1

Terminal Power Supply

3.37 Power for each terminal group is obtained from a standard O1 terminal power supply. Connection to the +130 and -48 volt office batteries or power supplies is through a Hubbel plug and connector. Power from the +130 and -48 volt supplies used for the level-control oscillator on the combining network and oscillator panel is obtained from ON terminal group 1. For a complete description of the ON terminal power supply, refer to Section 362-100-100.

Repeater Power Supply

3.38 The power supply for the ON repeater is similar to that for the N repeater described in Section 362-400-100. Provision is made for providing power to a distant N repeater over the

cable, or for receiving power from an adjacent locally powered N repeater. If sealing current is required by the cable, it can be provided in the same manner as in N carrier.

3.39 The power for a repeater at a powered repeater station is obtained from the +130 volt battery only. The power for transmission over the line to a nonpowered N repeater station is obtained from both the +130 and -130 volt batteries. This power is introduced through longitudinal choke coils onto the simplexes of the two pairs assigned to the system. Connection is made at the center tap of repeater input and output transformer windings. The pair that carries the plus or minus voltage is determined by the arbitrary rule that the positive dc current flows in the same direction as the direction of transmission.

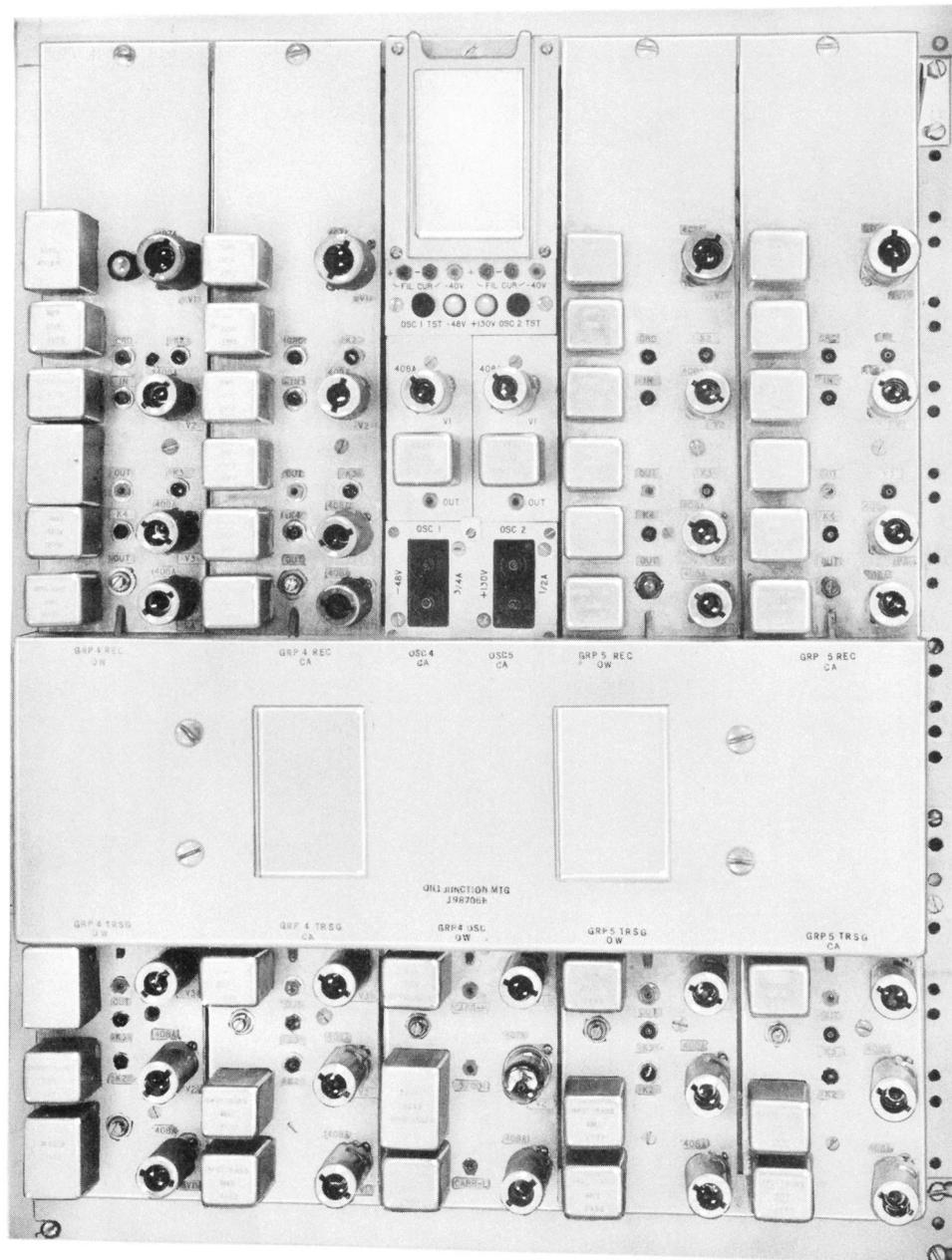
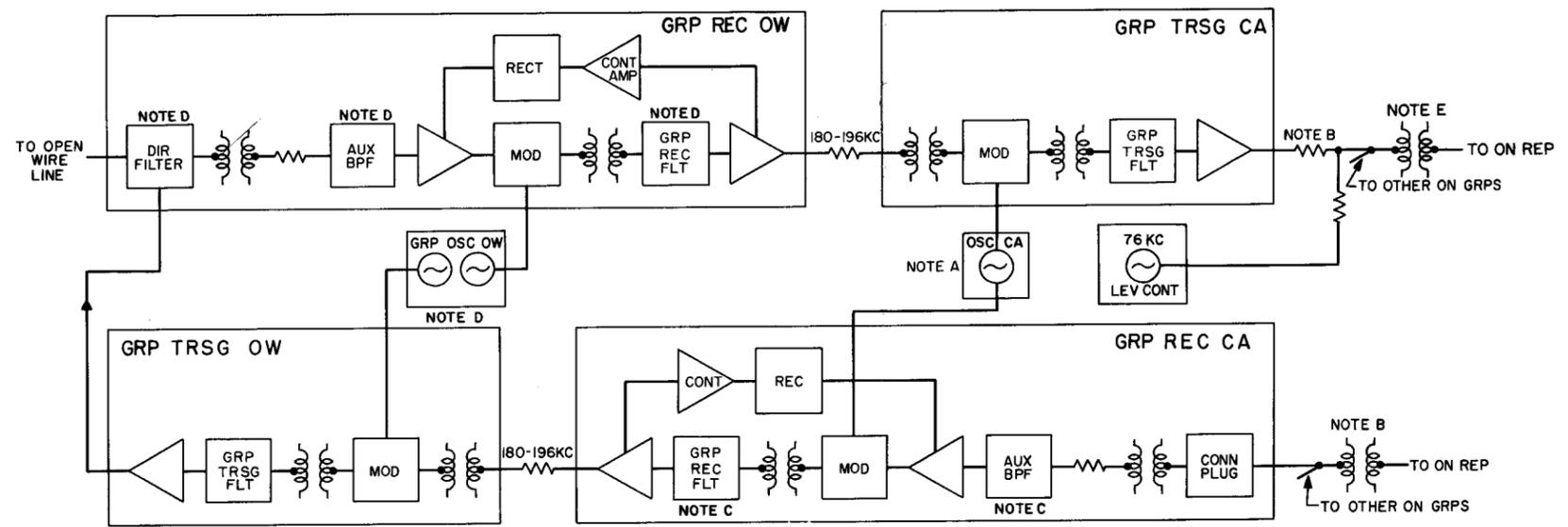


Fig. 25 — ON1 Junction — Combination of Any Two Groups of Groups 2, 3, 4, and 5

3.40 The power connections to the simplexes are made at the center tap of the appropriate repeater-input and output coils through the longitudinal choke coils L1 and L5 (see Fig. 28). These leads are brought out to terminals for the power supply cross connections. In the positive battery lead, at the power supply panel there is a 170-ohm current-limiting resistor and in the minus voltage lead, a 130-ohm fixed resistor and a 365-ohm variable resistor. The

variable resistor is adjusted to compensate for different line resistances and to provide for the normal adjustment, 140 volts, at the nonpowered repeater point. The power supply cross connections for various power-feed systems are shown on the schematic drawing. Provision has been made to supply sealing current from either the +130 or -130 volt battery in order to equalize the load on these batteries.



NOTES:

A -

GRP	FREQ KC
1	316
2	296
3	276
4	256
5	236

B -

GRP	FREQ KC
1	120-136
2	100-116
3	80-96
4	60-76
5	40-56

C -

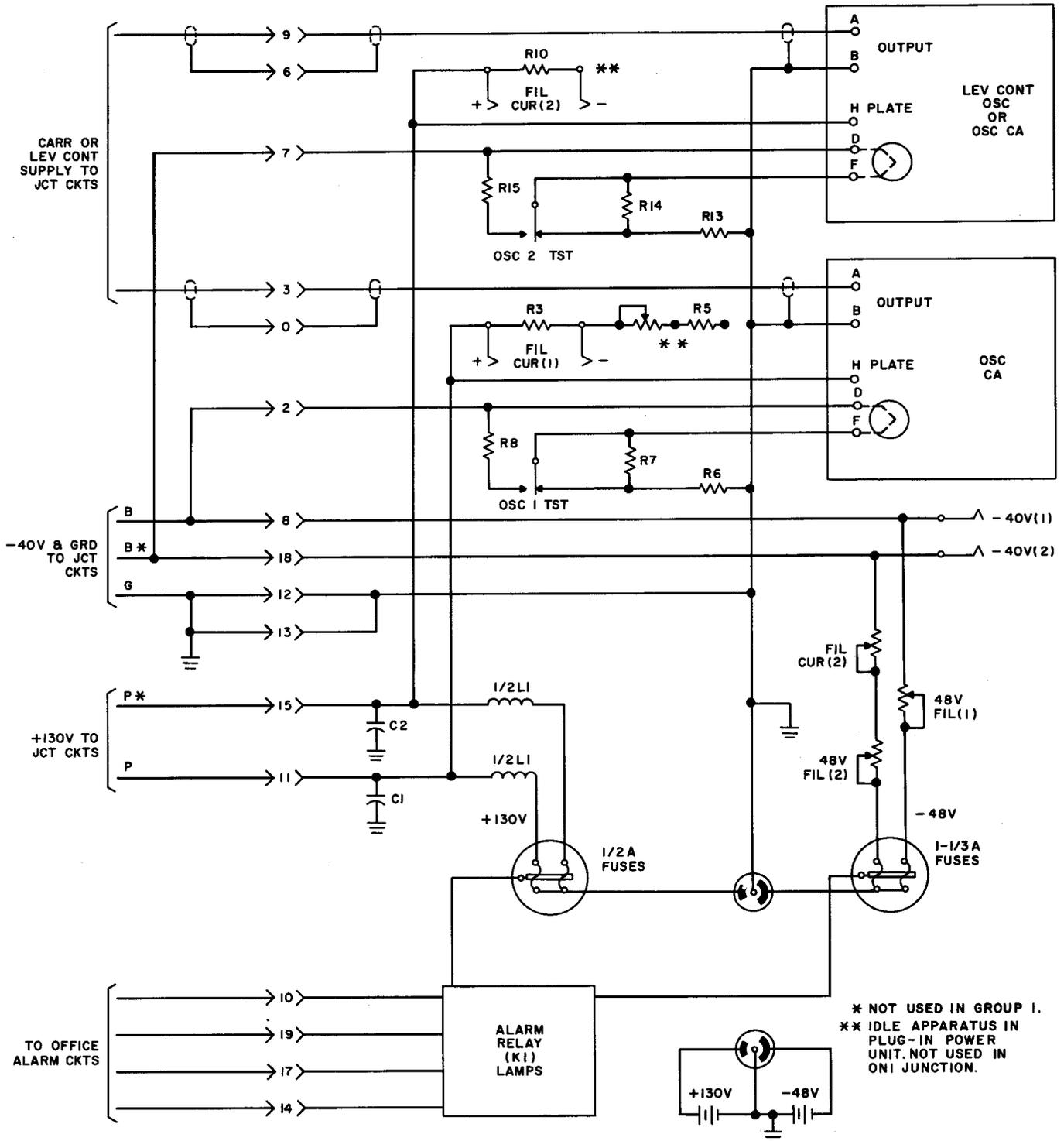
GRP	FILTER
1	530F
2	530D
3	530C
4	530R
5	530P

D- OSCILLATOR FREQUENCIES AND DIRECTIONAL FILTER CODES AND ORIENTATION CORRESPOND TO TYPE O SYSTEM TO WHICH JUNCTION GROUP CONNECTS AS COVERED IN SECTION E 44.015.

GRP REC OW	FLT	GRP REC OW	FLT
OB LGT	530R	OD LGT	530AA
OB HGT	530P	OD HGT	530F
OC LGT	530D	OA LGT	531F
OC HGT	530C	OA HGT	530J

E- NOT PROVIDED IN EARLIER EQUIPMENT.

Fig. 26 — ON1 Junction Group Schematic



* NOT USED IN GROUP I.
 ** IDLE APPARATUS IN PLUG-IN POWER UNIT. NOT USED IN ONI JUNCTION.

AS PER K WIRING FOR ONI JUNCTIONS

Fig. 27 — Junction Power Supply

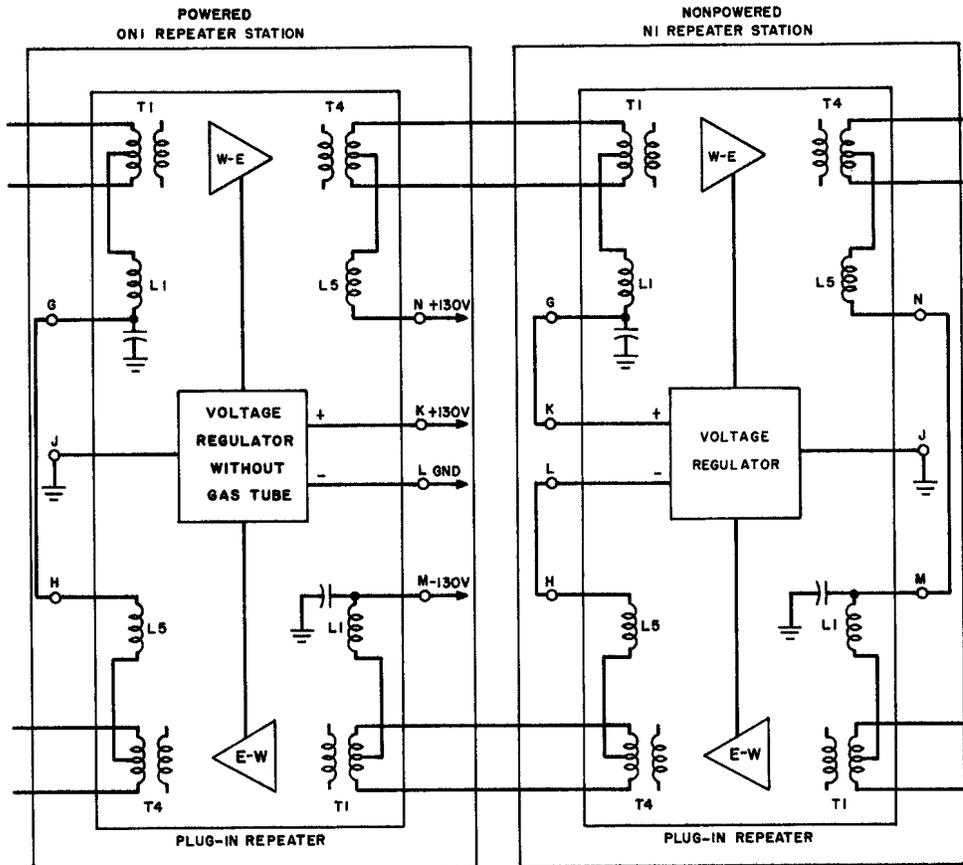


Fig. 28 — Typical Repeater Power Supply

4. ORDER-WIRE AND ALARM FACILITIES

4.01 Type ON systems will use existing order-wire and alarm facilities provided in the plant for testing and maintenance. For the cable portion, the standard N order-wire and alarm system is applicable.

4.02 The alarm circuit in each ON1 terminal group is the same as in an O1-type terminal. For detailed information on this circuit, see Section 362-100-100. In the case of ON2 carrier systems the O1 and ON1 alarm circuit is not satisfactory. The crosstalk from the 3700-cycle signaling tones of adjacent groups is of sufficient magnitude to hold the alarm circuit inoperative under legitimate alarm conditions. A transistor detector circuit serves as the initiating device for the carrier failure alarm of ON2 carrier systems and this circuit causes the terminal alarm circuit to operate when a carrier failure occurs. The output from the twin-channel carrier pick-off filter

of the carrier associated with channels 1 and 2 is fed to the detector. When the detector circuit initiates the alarm, the sequence and functions of the terminal alarm circuit are the same as for O1 and ON1 systems. In ON2 systems the carrier alarm arrangement is on a 4-channel basis, as it is in O1 or ON1 systems. The transistor detector circuit is assembled on a miniplas assembly, which in turn is located on the terminal mounting just to the left of the alarm panel. Part of the wiring required for the transistor detector circuit is in the terminal mounting and part is in the twin-channel unit.

4.03 The alarm circuit in the ON1 junction is the same as that provided in the O1-type repeater. At attended locations, connections will be made to the normal audible and visible alarms associated with the office. At unattended offices, provision is made for an alarm circuit into an attended point. For detailed information, refer to Section 362-100-100 or 362-010-150.

4.04 The alarm circuit in the ON-type repeater is the same as in the N-type repeater. Provision is made for transmitting the alarm from an unattended to an attended location. For detailed information refer to Sections 362-010-100 and 362-010-150.

5. REFERENCED CIRCUIT DESCRIPTIONS (NOT ATTACHED)

CD-95192-01	LL-LH	Repeater
CD-95193-01	LL-HL	Repeater
CD-95194-01	LH-LL	Repeater
CD-95195-01	HL-LL	Repeater

6. DRAWINGS (NOT ATTACHED)

SD-95118-01 — N1 and O1 Channel Circuit

SD-95118-03 — O1 and ON Schedule C and D Program Circuit

SD-95124-01 — Application Schematic for N1, ON1 and ON2 Repeaters

SD-95150-01 — Application Schematic O1 and ON Carrier Terminal

SD-95151-01 — O1, ON1, and ON2 Twin-Channel Carrier Circuit

SD-95152-01 — OB1, OC1, OD1 Group-Receiving or Repeater Amplifier and ON1 and ON2 Group-Receiving Circuit

SD-95153-01 — OB1, OC1, OD1, and ON1 and ON2 Group-Transmitting Circuit

SD-95154-01 — O1 Terminal Group Oscillator and ON1 and ON2 Group Oscillator Circuits

SD-95155-01 — Application Schematic — O1 Repeaters

SD-95158-01 — O1 Repeater Oscillator and Miscellaneous Oscillator and ON1 Miscellaneous Oscillator Circuits

SD-95163-01 — Channel Test Stand Circuit

SD-95165-01 — Application Schematic — Power Supply and Alarm Filter Circuit

SD-95172-01 — OA1 Group-Transmitting Circuit

SD-95174-01 — OA1 Group-Receiving Circuit

SD-95180-01 — Attended Office Alarm Circuit for Use with Pole Mounted Repeaters

SD-95181-01 — Application Schematic — Line Filter and Autotransformer Circuit

SD-95191-01 — N1, O1, ON1, and ON2 Thru Channel Circuit

SD-95192-01 — ON1 & ON2 Low-Low and Low-High Repeater Circuit

SD-95193-01 — ON1 & ON2 Low-Low and High-Low Repeater Circuit

SD-95194-01 — ON1 & ON2 Low-High and Low-Low Repeater Circuit

SD-95195-01 — ON1 & ON2 High-Low and Low-Low Repeater Circuit

SD-95196-01 — Application Schematic — ON1 Junction Group 1

SD-95197-01 — Application Schematic — ON1 Junction Groups 2 and 3 or 4 and 5

SD-95198-01 — ON Combining Network and Oscillator Circuit

SD-95216-01 — ON1 and ON2 Repeater Circuit for use on Radio, Low-Low and High-Low

SD-95218-01 — ON1 and ON2 Repeater Circuit for use on Radio, High-Low and Low-Low

SD-95224-01 — Slope Networks, Span Pads, and Artificial Line Circuits